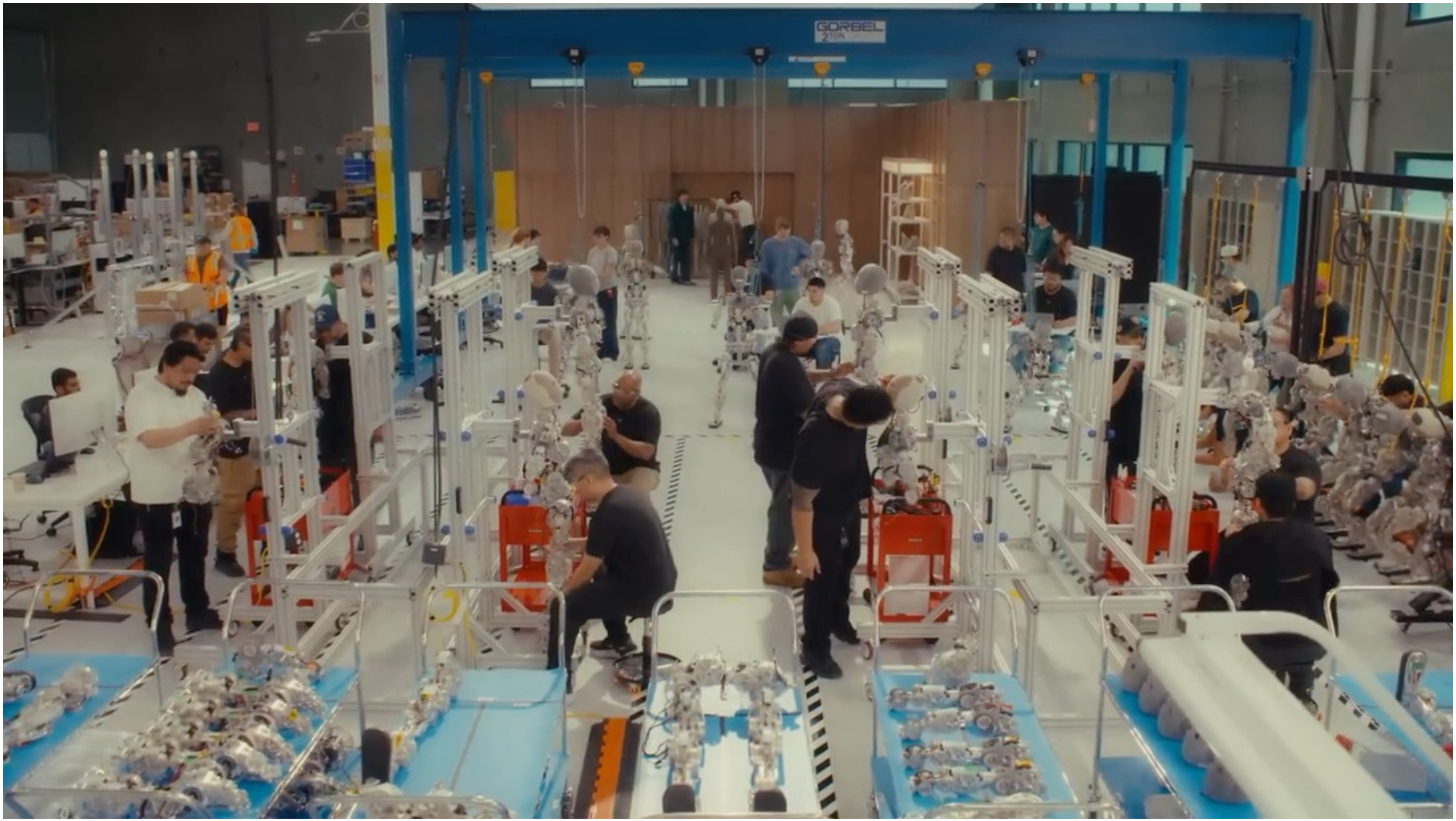
Lecture 02
The Rise of Robots & AI

Wan Fang

Southern University of Science and Technology

Robot of the Day

NEO Factory



NEO is Starting to Learn on Its Own

The Rise of Robots & AI

- Differences between Robots and AI
- The Rise of Robotics & AI – Part I before 1990
- The Rise of Robotics & AI – Part II after 1990
- Robotics & AI in Applications

Robots vs. AI

Robots are programmable machines that are usually able to carry out a series of actions autonomously, or semi-autonomously

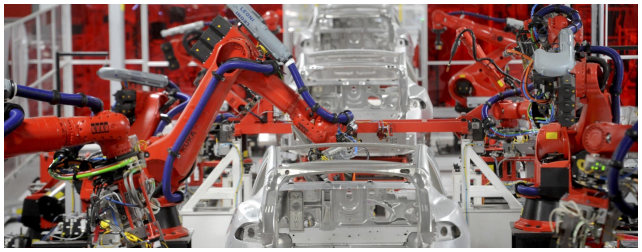
"sense, plan, and act"

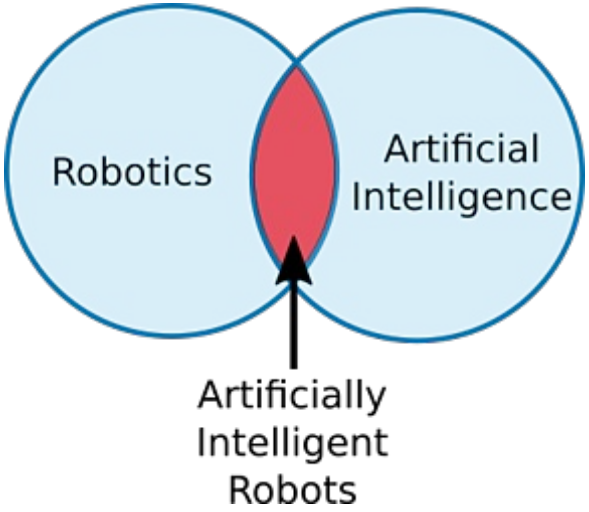
Artificial intelligence (AI) is a branch of computer science. It involves developing computer programs to complete tasks that would otherwise require human intelligence.

Tackle learning, perception, problem-solving, language-understanding and/or logical reasoning.

Most Robots …

- Take a phyical form
- Effect changes through physical interactions



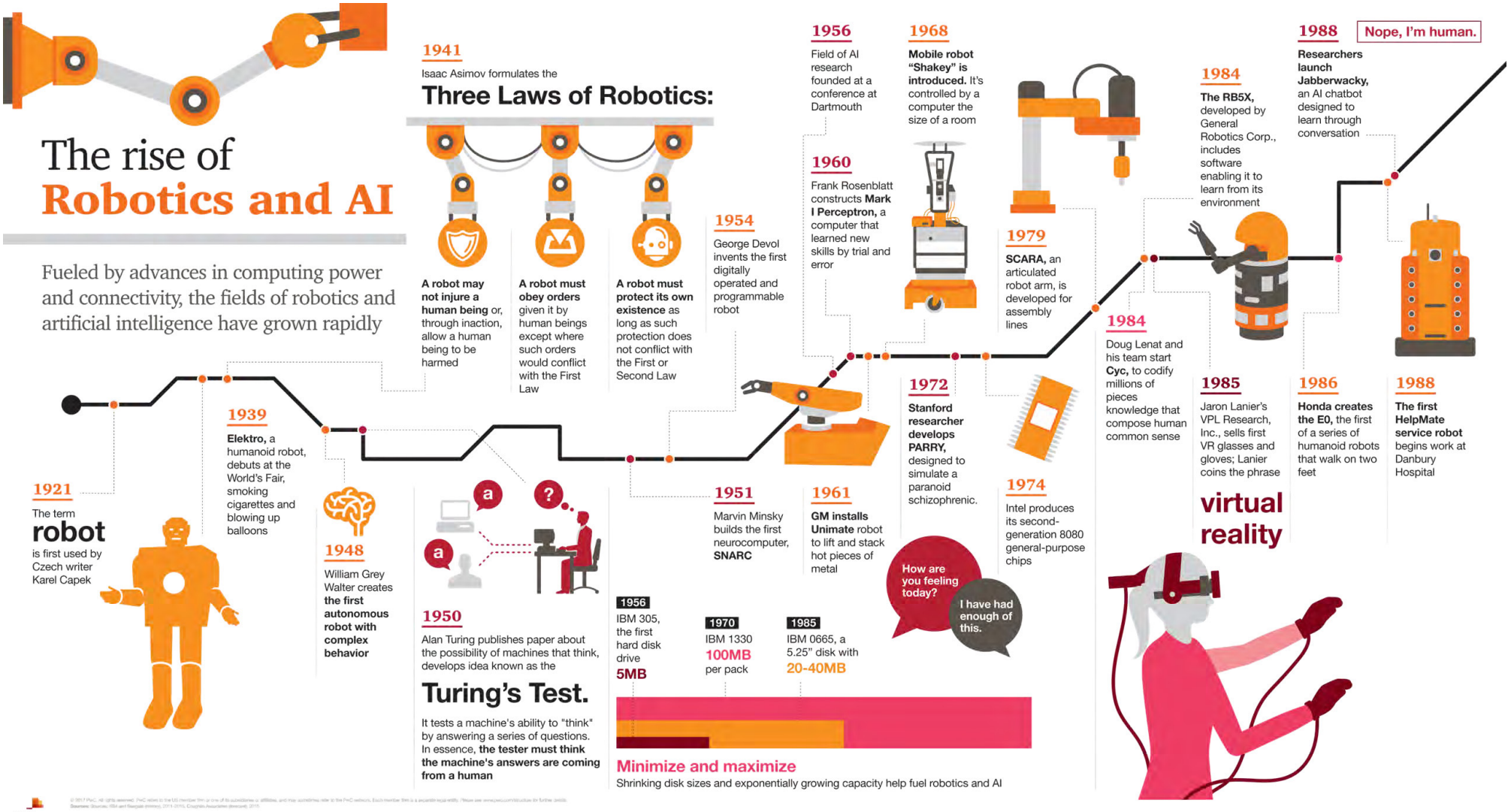


Most AI …

- Presented as programs
- Effect changes through data and decisions

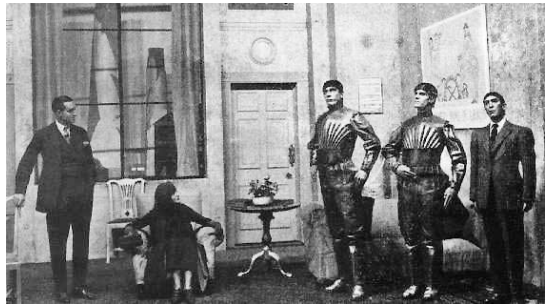
AlphaGo by Google & Mega Factory by Tesla

The Rise of Robotics & AI



R.U.R

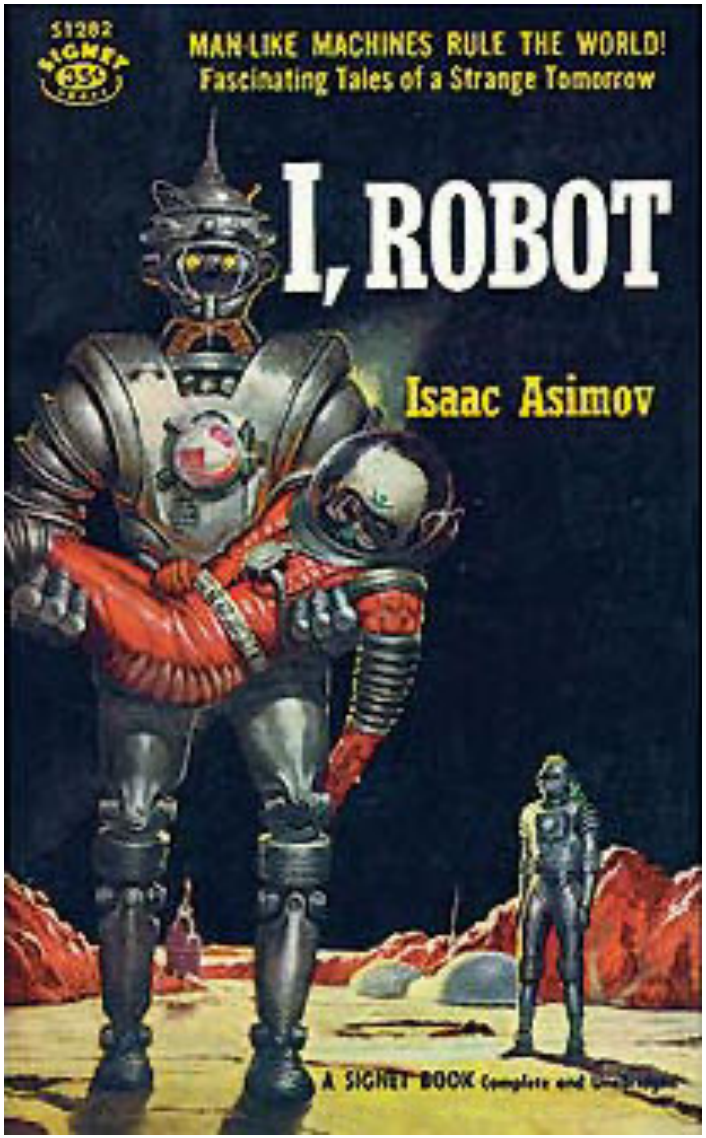
- R.U.R. is a 1920 science-fiction play by the Czech writer Karel Čapek.
  - "R.U.R." stands for Rossumovi Univerzální Roboti (**Rossum's Universal Robots**, a phrase that has been used as a subtitle in English versions).
  - The play had its world premiere on 2 January 1921 in Hradec Králové; it introduced the word "robot" to the English language and to science fiction as a whole. R.U.R. soon became influential after its publication.
- The Universal Robot Company



Rossums Universal Robots by Karel Capek & https://patch.com/california/walnutcreek/ev--rossums-universal-robots & https://en.wikipedia.org/wiki/R.U.R.

The Three Laws of Robotics

- The Three Laws of Robotics (Asimov's Laws)
  - A set of rules devised by science fiction author Isaac Asimov.
  - The rules were introduced in his 1942 short story "Runaround" (included in the 1950 collection I, Robot), although they had been foreshadowed in some earlier stories.
- The Three Laws, quoted from the "Handbook of Robotics, 56th Edition, 2058 A.D.", are:
  - **1st Law**: A robot may not injure a human being or, through inaction, allow a human being to come to harm.
  - **2nd Law**: A robot must obey the orders given it by human beings except where such orders would conflict with the First Law.
  - **3rd Law**: A robot must protect its own existence as long as such protection does not conflict with the First or Second Law.
  - **0th** Law: A robot may not harm humanity, or, by inaction, allow humanity to come to harm.



https://en.wikipedia.org/wiki/Three_Laws_of_Robotics

1941: The “Laws” of Robotics

1st Law: A robot may not injure a human being or, through inaction, allow a human being to come to harm.
2nd Law: A robot must obey the orders given it by human beings except where such orders would conflict with the First Law.
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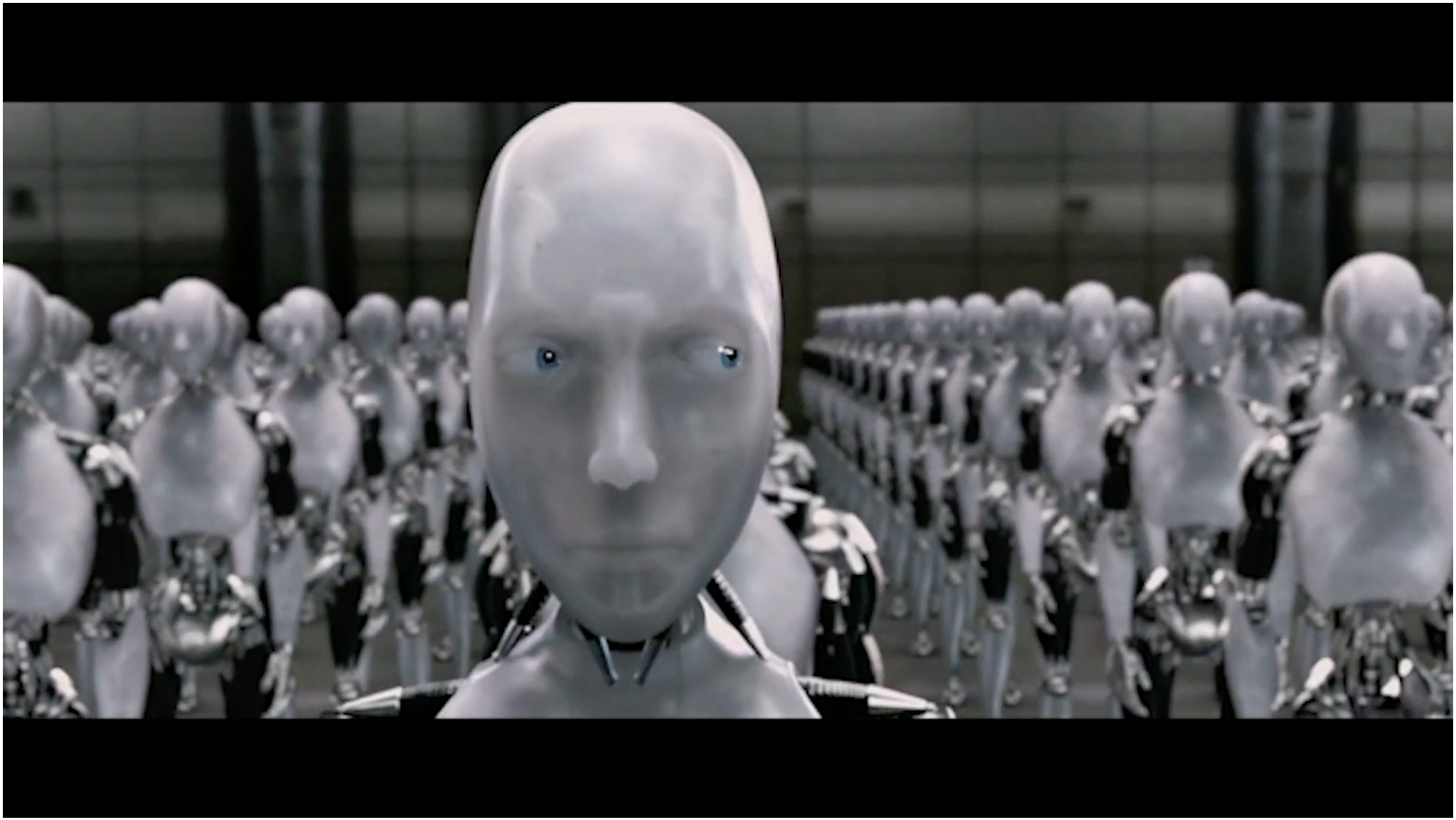
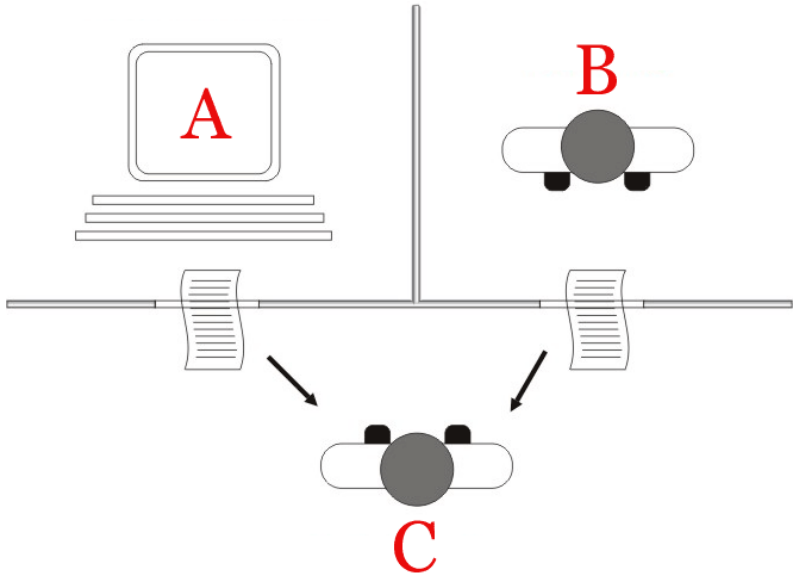


I, Robot Movie Trailer: https://www.youtube.com/watch?v=7Dlo-VB0-HI

The Turing Test

- Originally called *the imitation game* by Alan Turing in 1950, is a test of a machine's ability to exhibit intelligent behaviour equivalent to, or indistinguishable from, that of a human.
  - Turing proposed that a human evaluator would judge natural language conversations between a human and a machine designed to generate human-like responses.
  - The evaluator would be aware that one of the two partners in conversation was a machine, and all participants would be separated from one another. The conversation would be limited to a text-only channel, such as a computer keyboard and screen, so the result would not depend on the machine's ability to render words as speech.



VOL. LIX. No. 236.] [October, 1950

MIND

A QUARTERLY REVIEW

OF

PSYCHOLOGY AND PHILOSOPHY

I.—COMPUTING MACHINERY AND INTELLIGENCE

BY A. M. TURING

1. *The Imitation Game.*

I PROPOSE to consider the question, 'Can machines think?' This should begin with definitions of the meaning of the terms 'machine' and 'think'. The definitions might be framed so as to reflect so far as possible the normal use of the words, but this attitude is dangerous. If the meaning of the words 'machine' and 'think' are to be found by examining how they are commonly used it is difficult to escape the conclusion that the meaning and the answer to the question, 'Can machines think?' is to be sought in a statistical survey such as a Gallup poll. But this is absurd. Instead of attempting such a definition I shall replace the question by another, which is closely related to it and is expressed in relatively unambiguous words.

The new form of the problem can be described in terms of a game which we call the 'imitation game'. It is played with three people, a man (A), a woman (B), and an interrogator (C) who may be of either sex. The interrogator stays in a room apart from the other two. The object of the game for the interrogator is to determine which of the other two is the man and which is the woman. He knows them by labels X and Y, and at the end of the game he says either 'X is A and Y is B' or 'X is B and Y is A'. The interrogator is allowed to put questions to A and B thus:

C: Will X please tell me the length of his or her hair?

https://en.wikipedia.org/wiki/Turing_test

Unimate (Universal Automation)

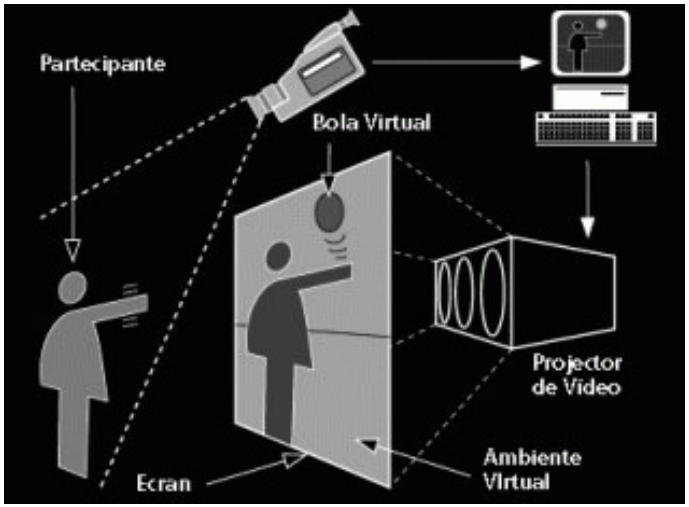
- **The Unimate was the first industrial robot ever built.** It was a hydraulic manipulator arm that could perform repetitive tasks. It was used by car makers to automate metalworking and welding processes.

https://robots.ieee.org/robots/unimate/

Virtual Reality

- Jaron Lanier and Thomas Zimmerman founded VPL Research, Inc. **This company is known as the first company to sell VR goggles and gloves.** (founded in 1984) They developed a range of VR equipment, such as, the DataGlove, EyePhone HMD and the Audio Sphere.

Krueger's VIDEOPLACE, the first interactive VR platform, was displayed at the Milwaukee Art Center in 1975.

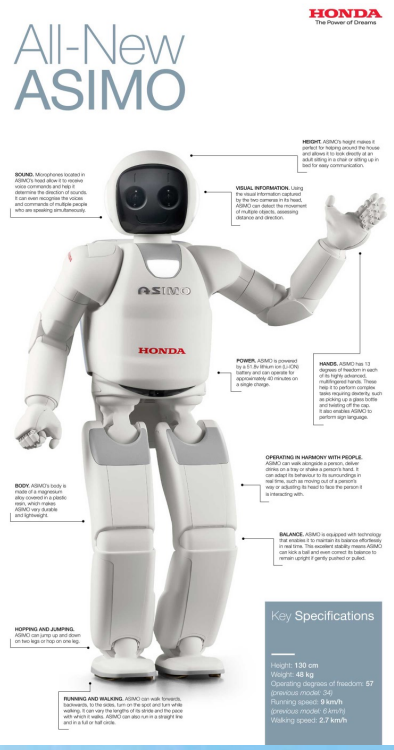


https://virtualspeech.com/blog/history-of-vr

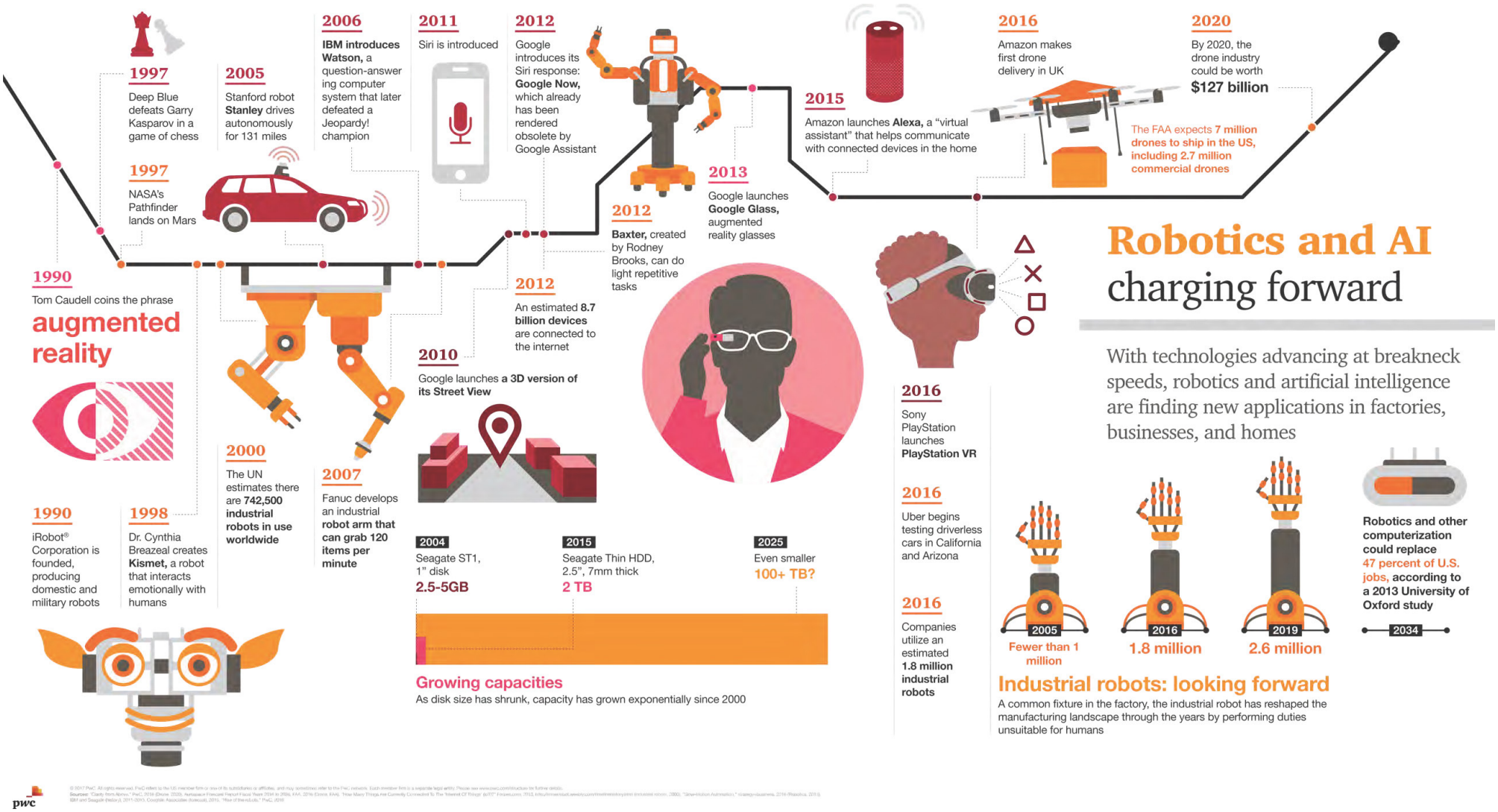
HONDA's ASIMO

Advanced **S**tep in **I**nnovative **MO**bility

- Humanoid Design for Advanced Robotics usually takes an iterative process that requires a great amount of **time, money, technology** and **public acceptance**.



The Rise of Robotics & AI



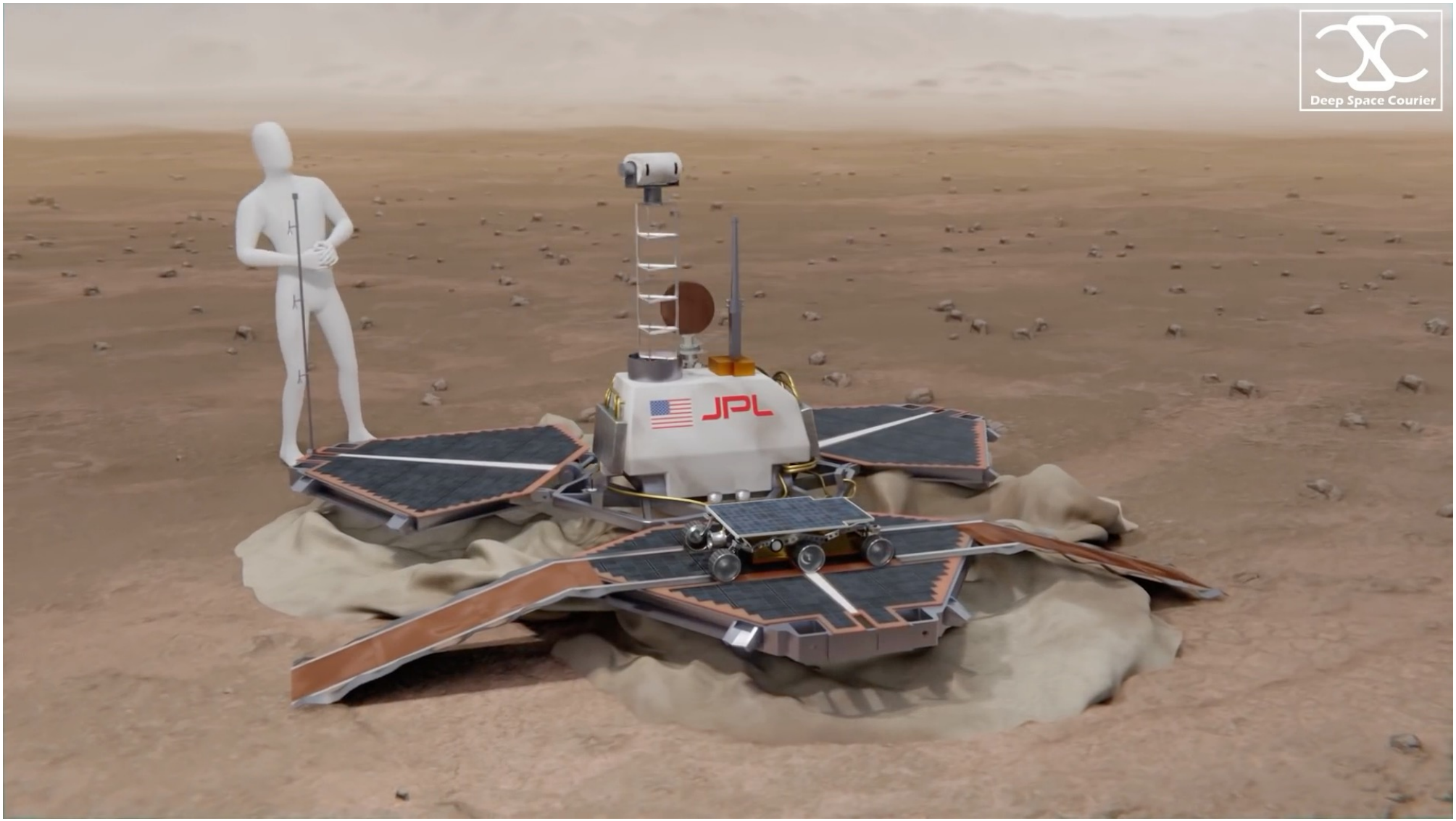
From Research to Space, then Military to Domestics

https://www.youtube.com/watch?v=A5H9mkr_NYE

Human vs. Agent (Computer? Robot?)

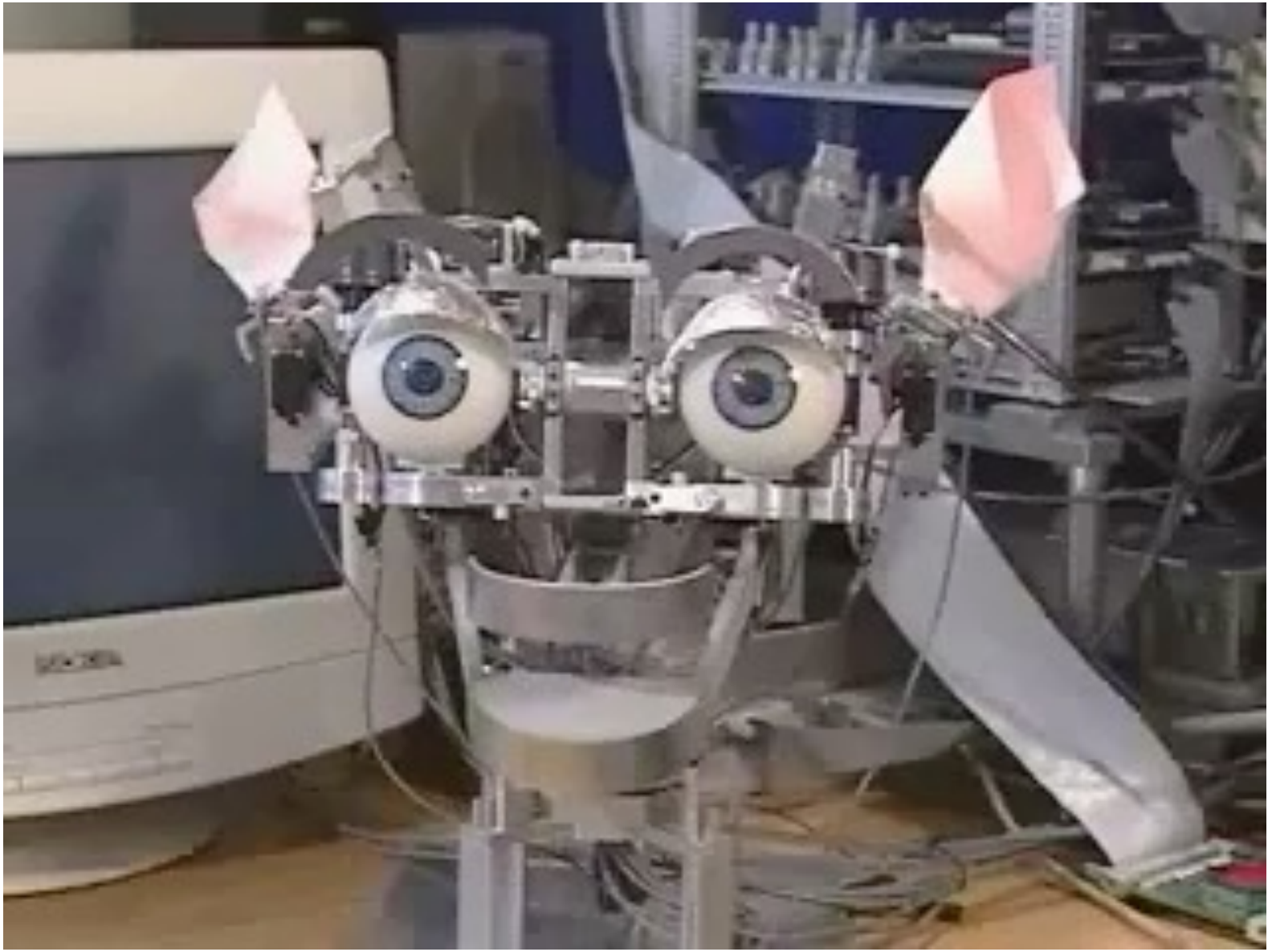
https://media.pri.org/s3fs-public/styles/story_main/public/story/images/DeepBlue.png?itok=N01yMnCK

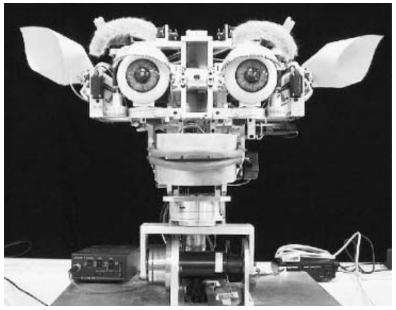
The 1st Rover Running on Mars

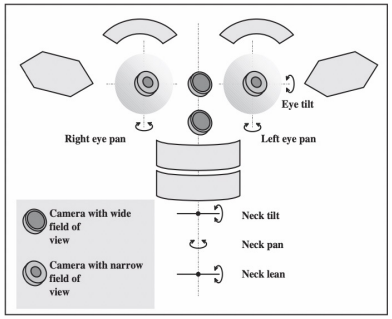


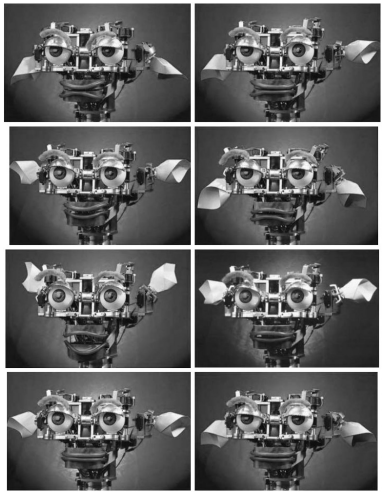
https://www.youtube.com/watch?v=ER6EO4B7V68

Kismet the Social Robot





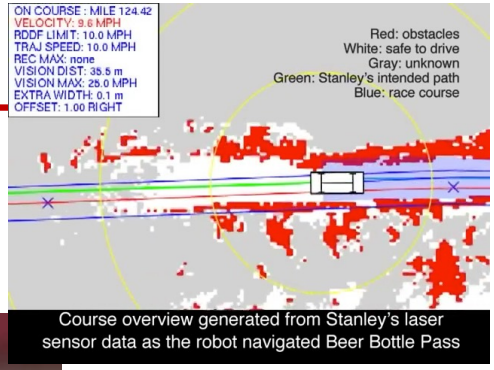




https://www.youtube.com/watch?v=Kw-gOmJwzuc

2005: Autonomous Vehicles

Stanley



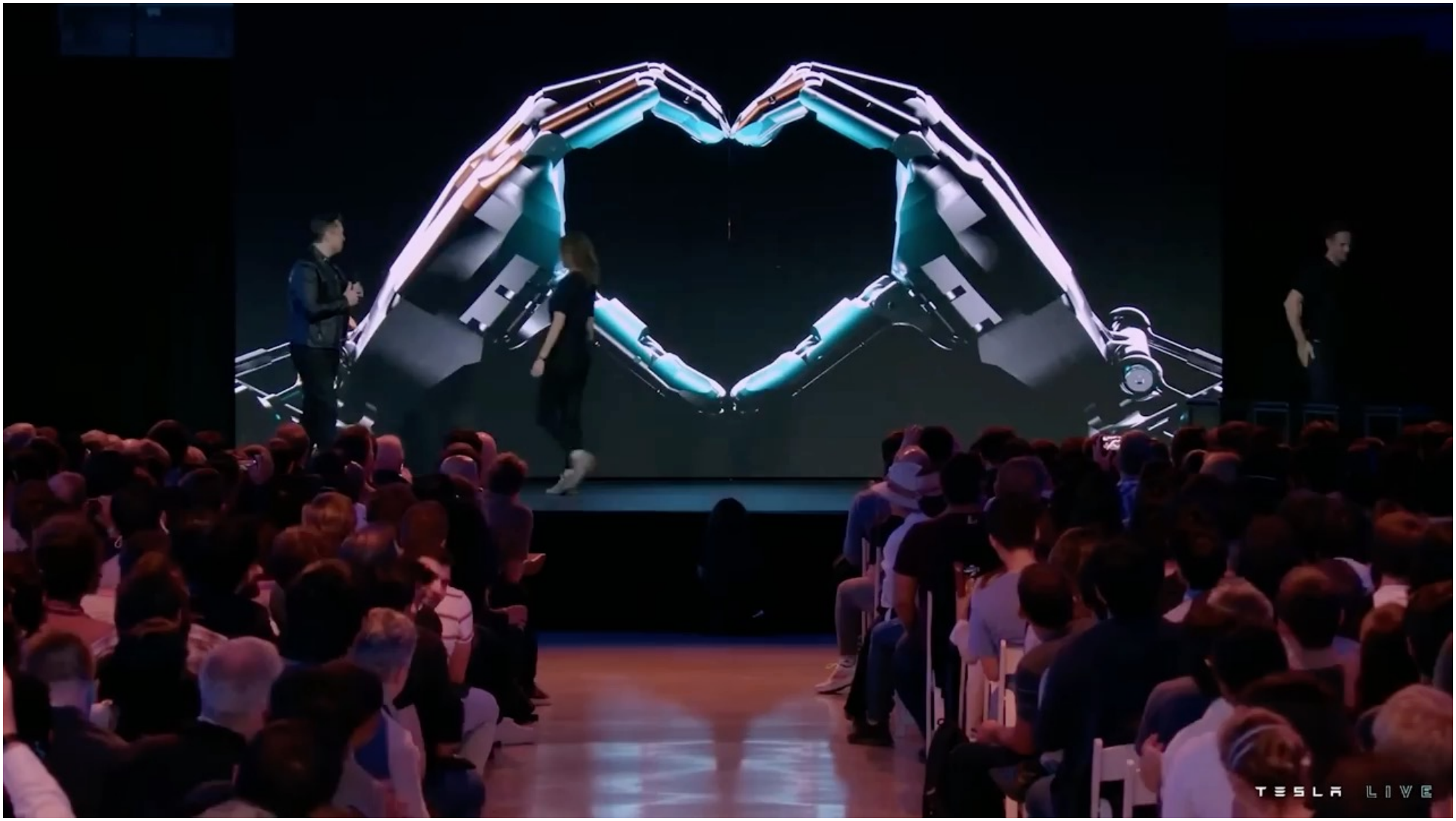
Course overview generated from Stanley's laser sensor data as the robot navigated Beer Bottle Pass

https://www.youtube.com/watch?v=2gQ3P5BpLjQ

Baxter

https://www.youtube.com/watch?v=NoKONzD-XsQ

Tesla Optimus vs. Boston Dynamics Atlas



https://www.youtube.com/watch?v=0QuXgUMcGLI

HUMANOID ROBOTS 2024

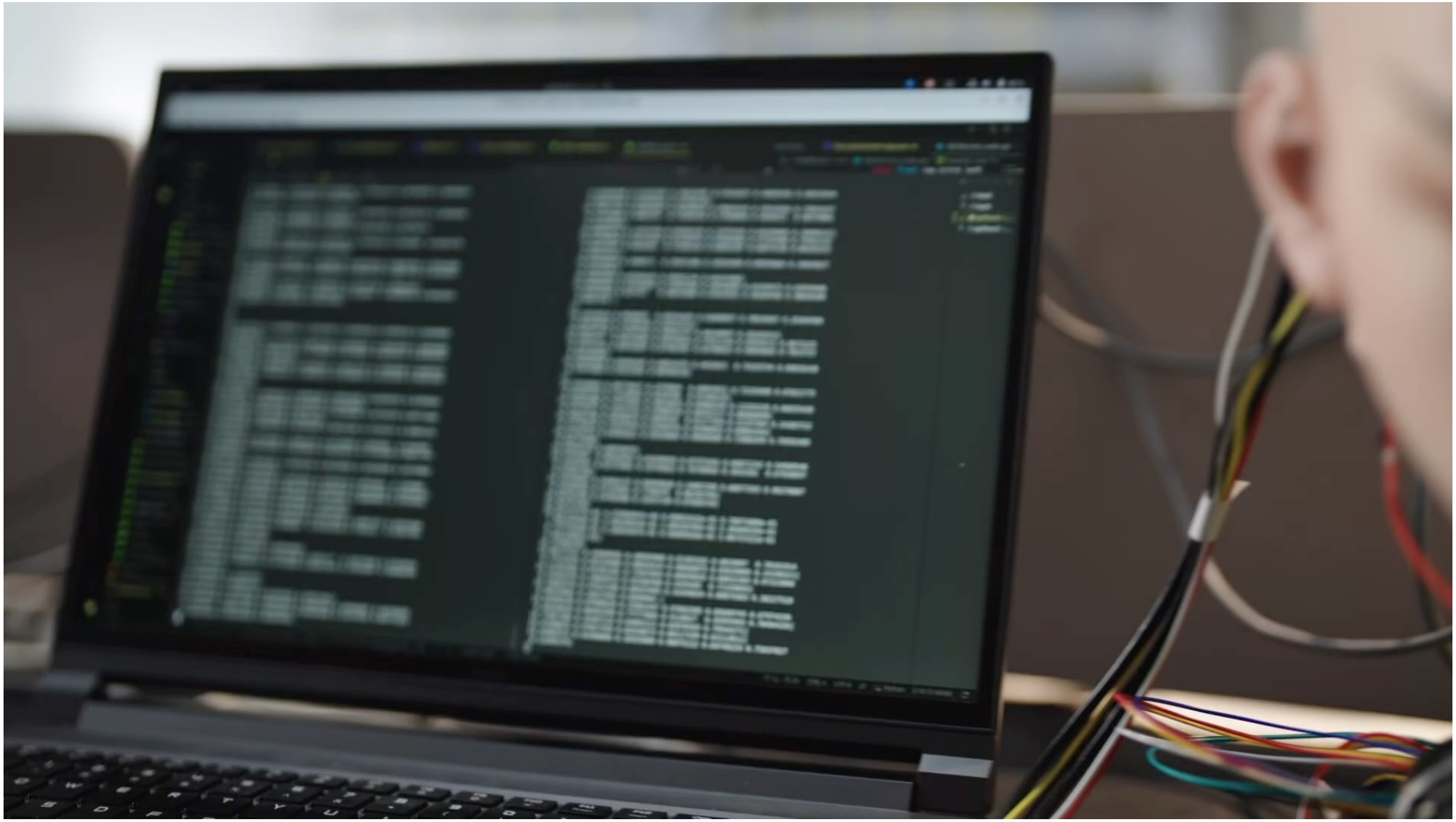
HD Atlas	NEO	GR-1	01	Phoenix	Apollo	Digit	Atlas	H1	Optimus Gen 2
Boston Dynamics	1x	Fourier	Figure	Sanctuary AI	Apptronik	Agility	Boston Dynamics	Unitree	Tesla
150cm / 4'11"	160cm / 5'3"	165cm / 5'5"	167cm / 5'6"	170cm / 5'7"	172cm / 5'8"	175cm / 5'9"	175cm / 5'9"	180cm / 5'11"	180cm / 5'11"
103lb | 47kg	66lb | 30kg	121lb | 55kg	132lb | 60kg	154lb | 70kg	159lb | 72kg	146lb | 64kg	180lb | 80kg	103lb | 47kg	103lb | 47kg
5mph | 8kmh	7.4mph | 12kmh	5mph | 8kmh	2.6mph | 4.3kmh	3mph | 5kmh	7.4mph | 12kmh	3.3mph | 5.4kmh		11mph | 18kmh	5mph | 8kmh

180lb | 81kg
8mph | 13kmh

SOURCE: WWW.LIFEARCHITECT.AI/HUMANOIDS/

MADE VISUAL

Biomimetic Humanoid Robot by AheadForm

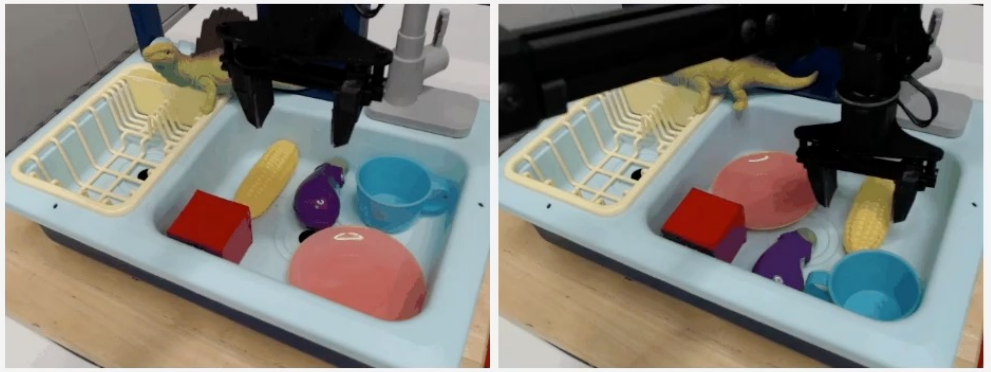


The OpenVLA Model

Source

Put Eggplant into Pot

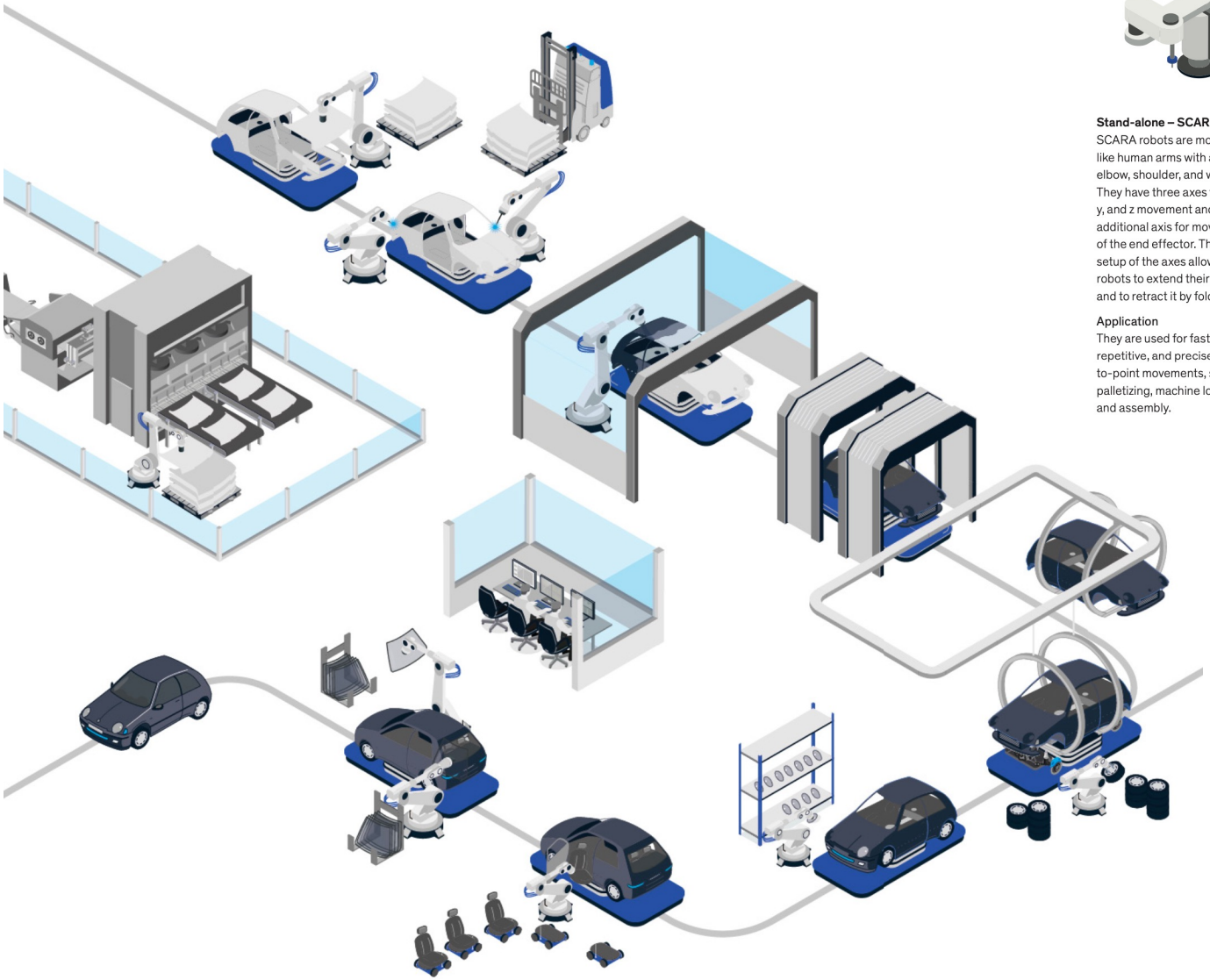
Put Yellow Corn on Pink Plate



Put Blue Cup on Plate

Put Eggplant into Pot

Example of Automotive Production Line



Stand-alone – SCARA
SCARA robots are modelled like human arms with an elbow, shoulder, and wrist. They have three axes for x, y, and z movement and an additional axis for movement of the end effector. The setup of the axes allows the robots to extend their arm and to retract it by folding up.

Application
They are used for fast, repetitive, and precise point-to-point movements, such as palletizing, machine loading, and assembly.

Collaborative
Collaborative robots directly interact with human workers without safety fences and are equipped with machine learning capabilities for easier programming.

Application
They are used to support human workers' strength and precision for certain movements, in processes that require flexibility and reprogramming, or where space is limited.

Autonomous guided vehicles (AGVs) and autonomous mobile robots (AMRs)[6]
AGVs and AMRs are not fixedly installed but mobile. Navigation is either onboard (e.g., camera or laser based) for most advanced types or external (e.g., path based using magnetic tape, wire, or rails on the ground).

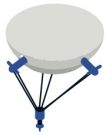
Application
Mobile robots are used for logistics and delivery as well as for moving pieces, such as boxes, pallets, or tools, in industrial settings between machinery, transfer points, or storage areas.

Exoskeletons
Exoskeletons are connected to the human body for support during heavy-duty or ergonomically challenging process steps. They are designed to boost the strength of human workers, e.g., increasing humans' capacity to carry heavy weight.

Application
They can be used in industrial applications to support worker movements (e.g., lifting in warehouses).

Stand-alone – articulated
Articulated robots have rotary joints and between three and six degrees of freedom enabling high flexibility (robot can bend back and forth).

Application
Articulated robots are used for a range of applications, e.g., assembly, painting, arc or spot welding, palletizing, and material handling.



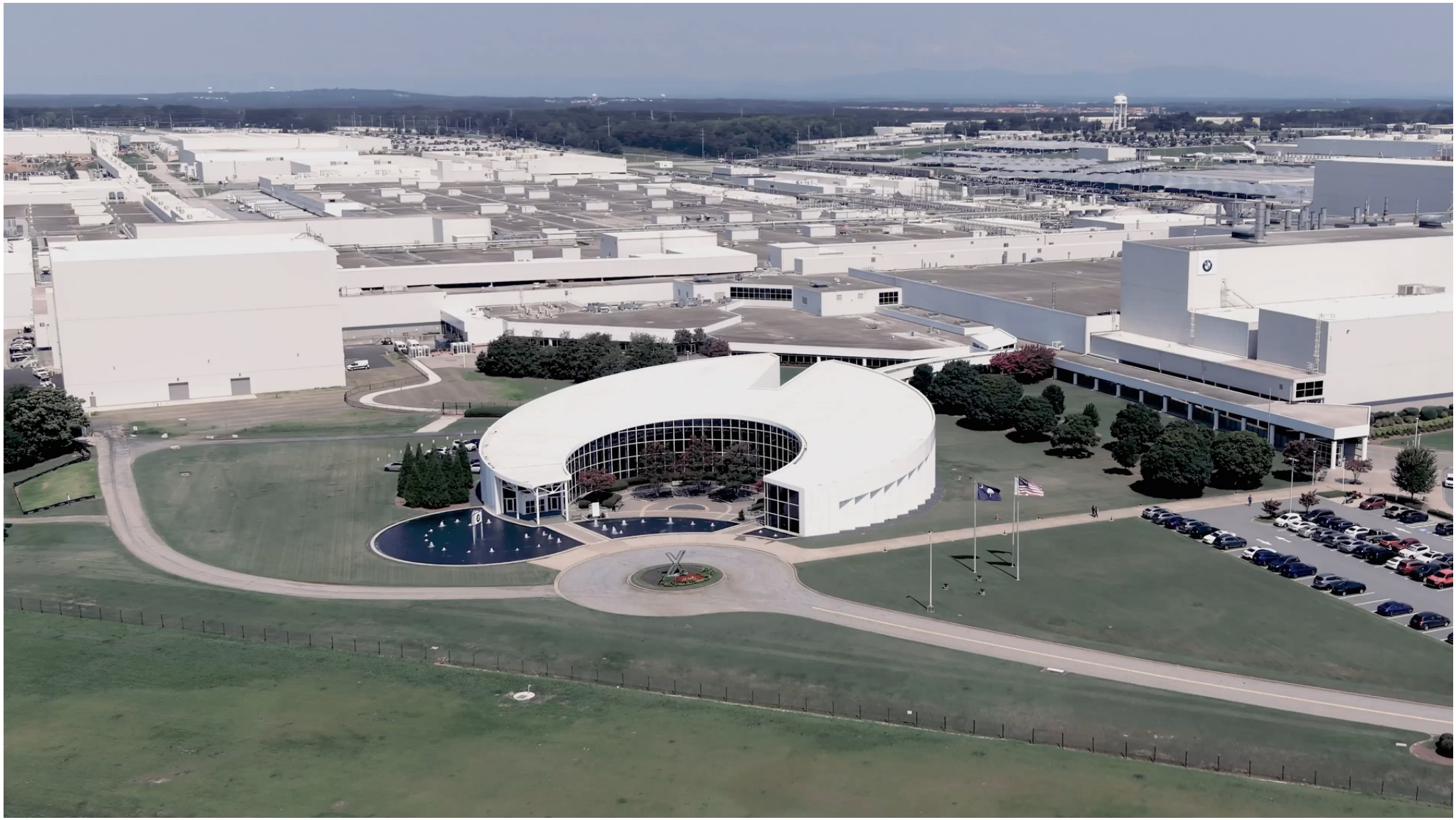
Stand-alone – delta
Delta (also: parallel) robots have three arms that are connected to a base platform via universal joints. Their arms are arranged as parallelograms to restrict the movement of the end platform. Actuators are located at the base platform, so that passive arms can be lightweight and move with great speed.

Application
Applications that require great precision and speed: common applications include packaging, high-precision assembly, and material handling.

Stand-alone –gantry/ linear/Cartesian
Cartesian robots consist of three axes of control that are situated at 90 degree angles of each other. The axes do not rotate but move in straight lines, which simplifies robot control – linear robots are comparably simple.

Application
With no need for pedestals, Cartesian robots are useful where space is limited, as they can be mounted overhead.

Example of Automotive Production Line



A Look at Robots Ready for Work

Five ways robots are going mainstream

They're not restricted to structured environments.

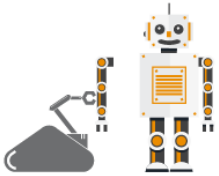
They can now handle dynamic, less predictable settings. In hospitals, robots can safely roam halls and deliver medications. In hotels, they can deliver towels, toiletries, and minibar items to guest rooms.

They can work with humans.

Thanks to sensors and smart technology, new-generation robots are much safer around humans.

They can learn.

The new robots can "learn" skills through trial and error, mimicking the way humans learn new tasks.



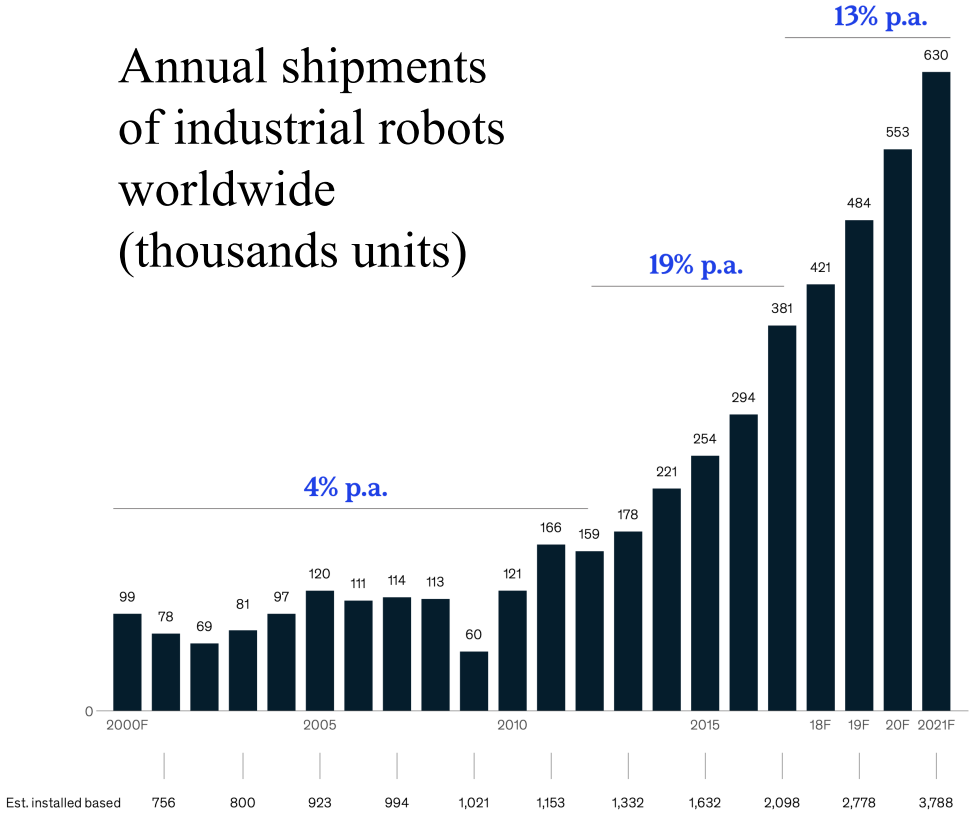
They are no longer single-task machines.

Robots are being designed with modularity in mind, beginning with a platform upon which a customized solution can be built.

They're moving beyond the factory floor.

Robots are engaged in functions across the enterprise, including positions where they interact directly with customers and employees.

Annual shipments of industrial robots worldwide (thousands units)



pwc & McKinsey

A Look at Robots Ready for Work

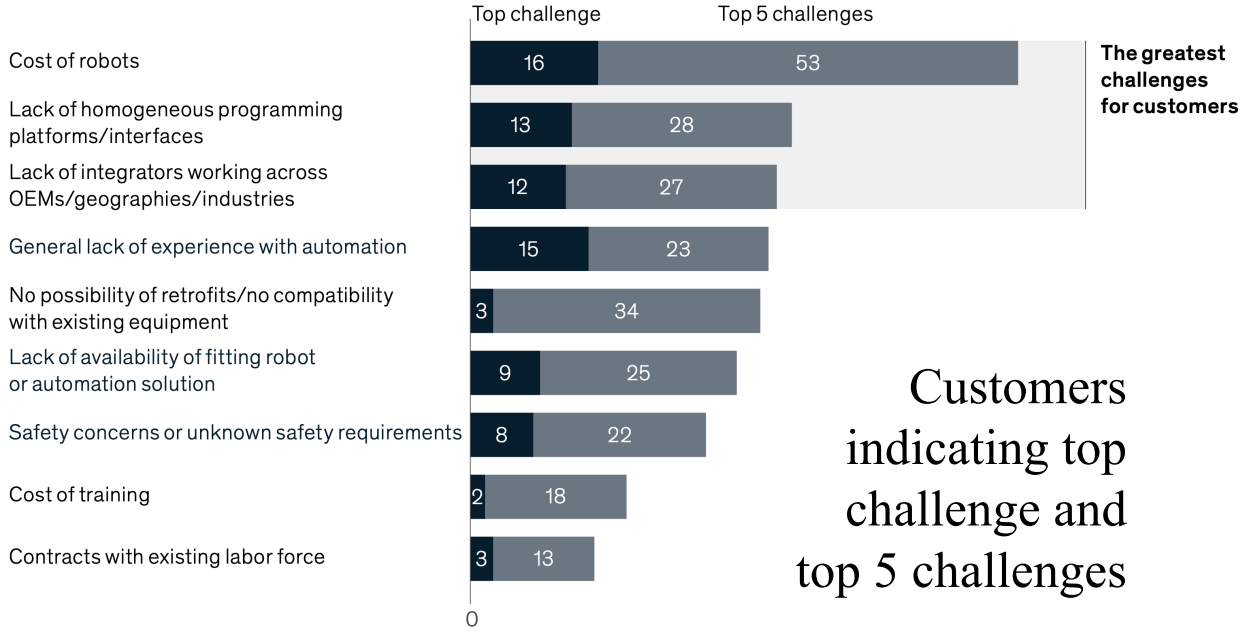
Benefits of robotics

Robots are not just for manufacturing anymore. No matter the industry, they can:

- Automate business operations
- Boost efficiency, quality, and repeatability
- Free up humans for higher-value tasks
- Replace or augment humans in jobs where there are labor shortages

Potential challenges

Lack of expertise and support	Your company may not have the knowledge or the resources to buy and maintain robots.
Fallout from job losses	Robots could displace workers, which could lower morale and create conflict with labor unions.
Regulatory compliance	Safety rules and monitoring and reporting requirements can create burdens, particularly for smaller companies.
Costs	Prices for robots are dropping, but the cost of engineering the system, installing it, and managing the change can be prohibitive.



Customers indicating top challenge and top 5 challenges

pwc & McKinsey

A Look at Robots Ready for Work

Robot Unit Number (Millions) Forecast by Type Source: Citi GPS

	2024	2025	2030	2035	2050	CAGR
Autonomous Vehicle	27	34	126	380	1,858	17.4%
Domestic Cleaning Robot	286	326	541	793	1,188	5.3%
Humanoids	0	0	1	13	648	60.7%
AGV & AMR	2	3	9	28	181	17.7%
Drone	37	40	54	73	149	5.4%
Caring Robot	0	1	6	18	71	20.0%
Commercial Cleaning Robot	1	2	6	14	25	10.6%
Food & Grocery Delivery Robot	0	0	4	11		
Food Service Robot	0	0	3	10		
Caring Overlap	0	0	(1)	(5)		
Total	354	405	749	1,337		

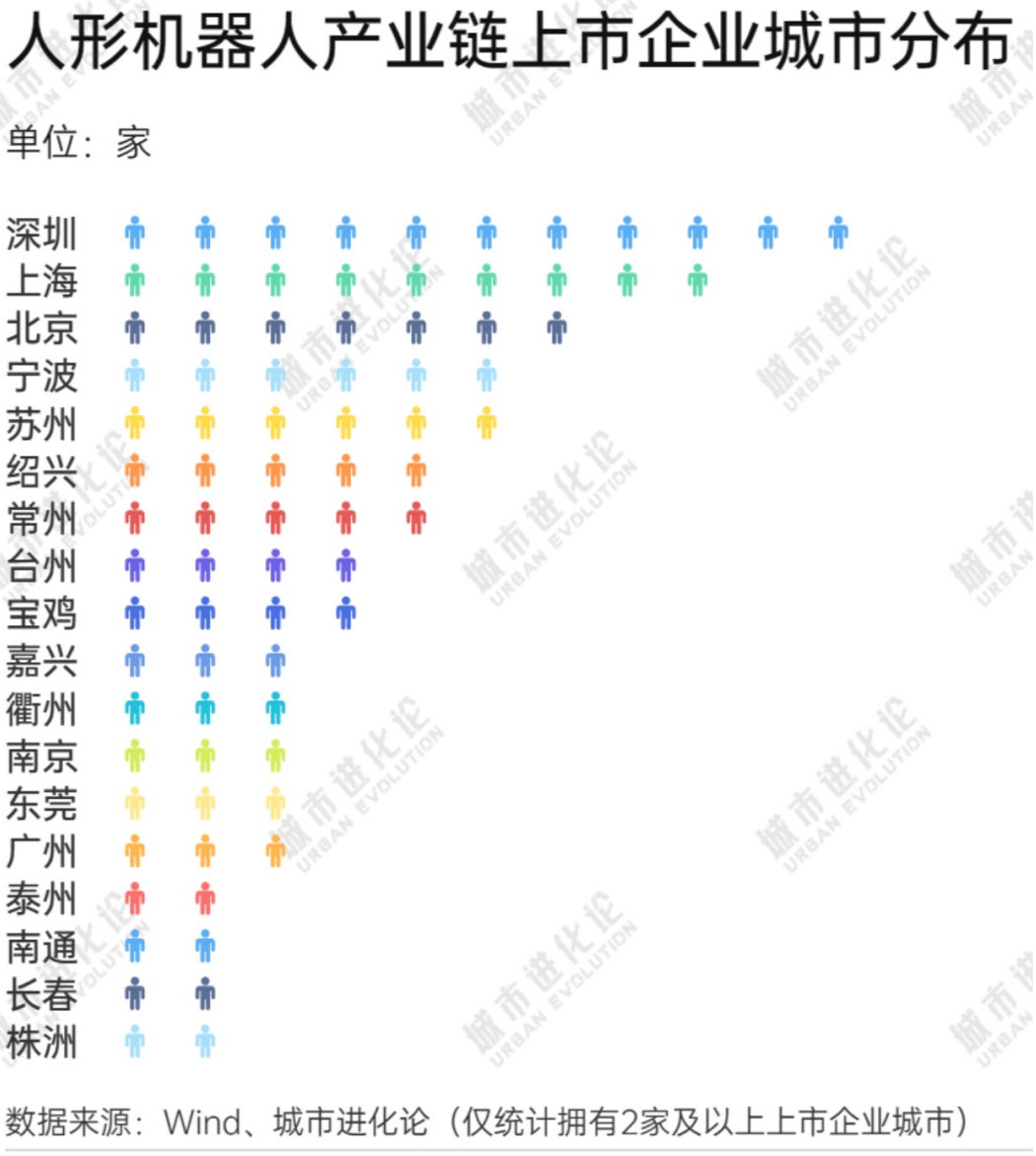
Figure 36. Humanoid Analysis Breakdown by Use Case (in mn units)

Use Case	2035	2050	CAGR
Home Services	7.9	411.2	30%
Industrials	4.6	164.2	27%
Construction	0.4	44.4	37%
Parcel Delivery	0.0	13.3	48%
Food & Grocery Delivery	0.0	6.9	44%
Supermarkets	0.2	6.4	25%
Hospitality	0.0	0.8	22%
Total	**13.2**	**647.2**	**30%**

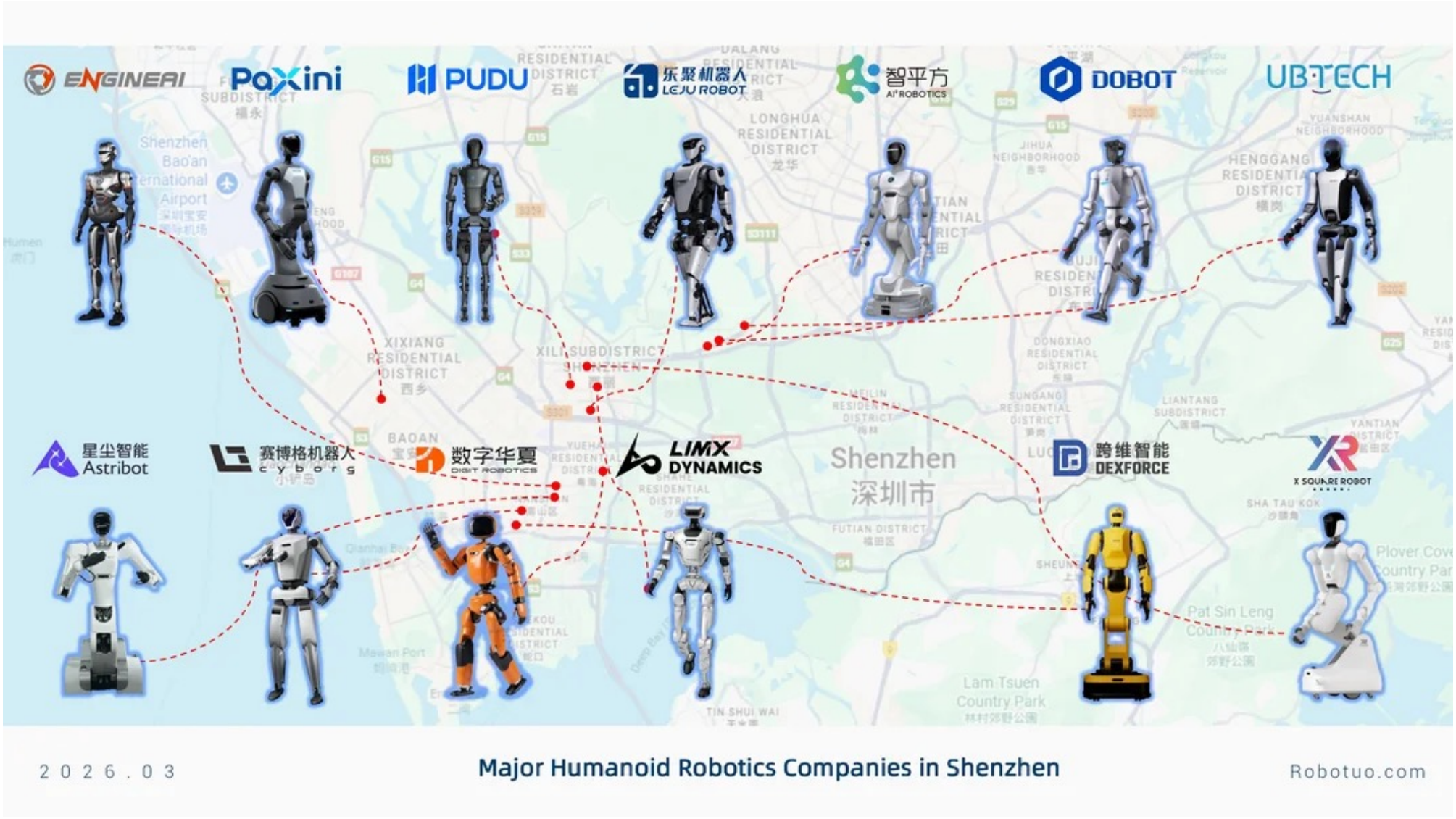
Source: Citi GPS

The Humanoid Industry Chain in Shenzhen

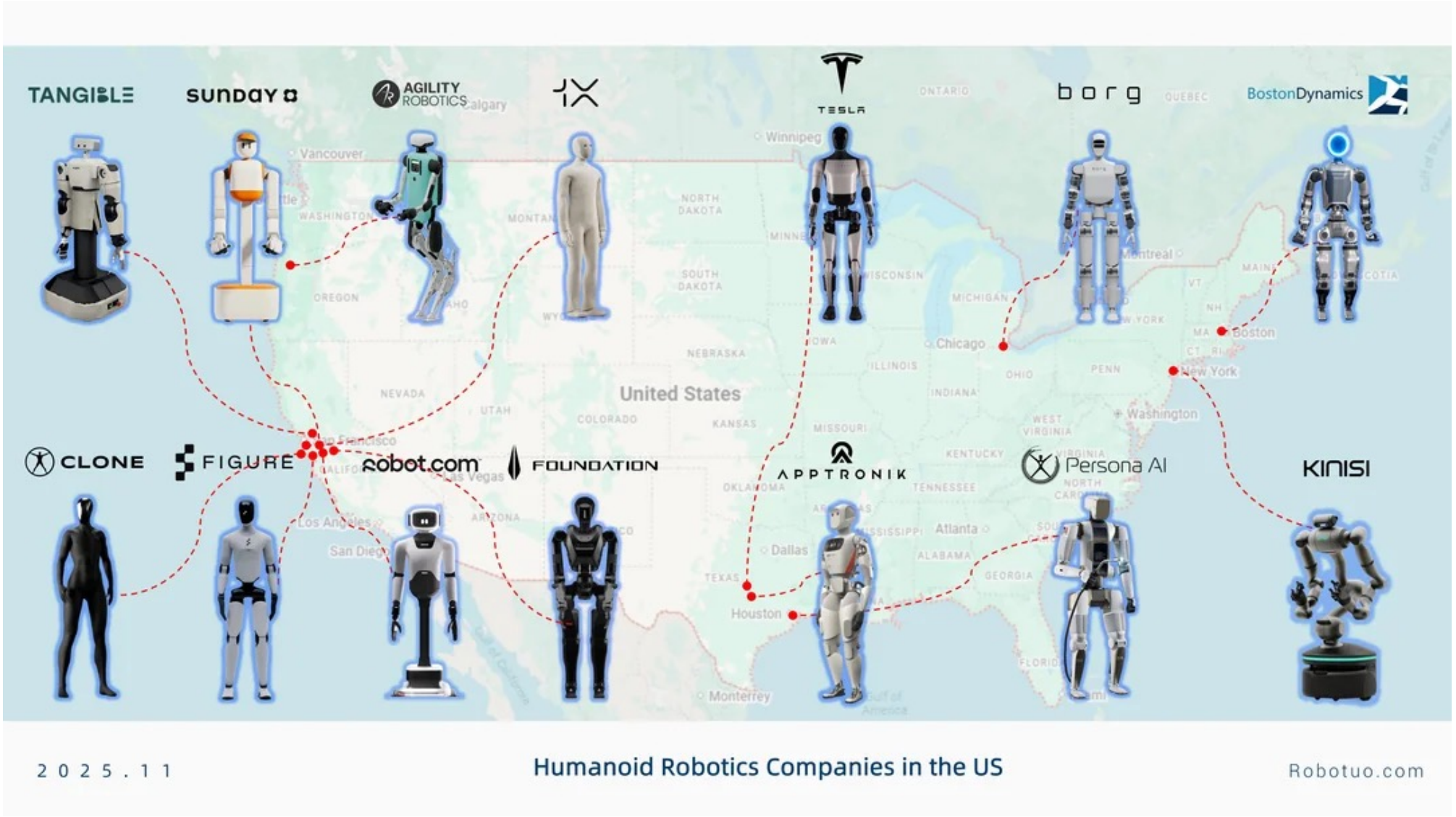
- China has become the world's largest robot market. In 2022, the industry generated > RMB 170 billion in revenue.
- China ranked first globally in industrial robot installations, 392 units per 10,000 manufacturing workers.
- Shenzhen has one of the most comprehensive robotics industry chains in China. Nanshan District and Bao'an District have the largest concentrations of robotics companies in the city.



The Humanoid Industry in Shenzhen



The Humanoid Industry in US



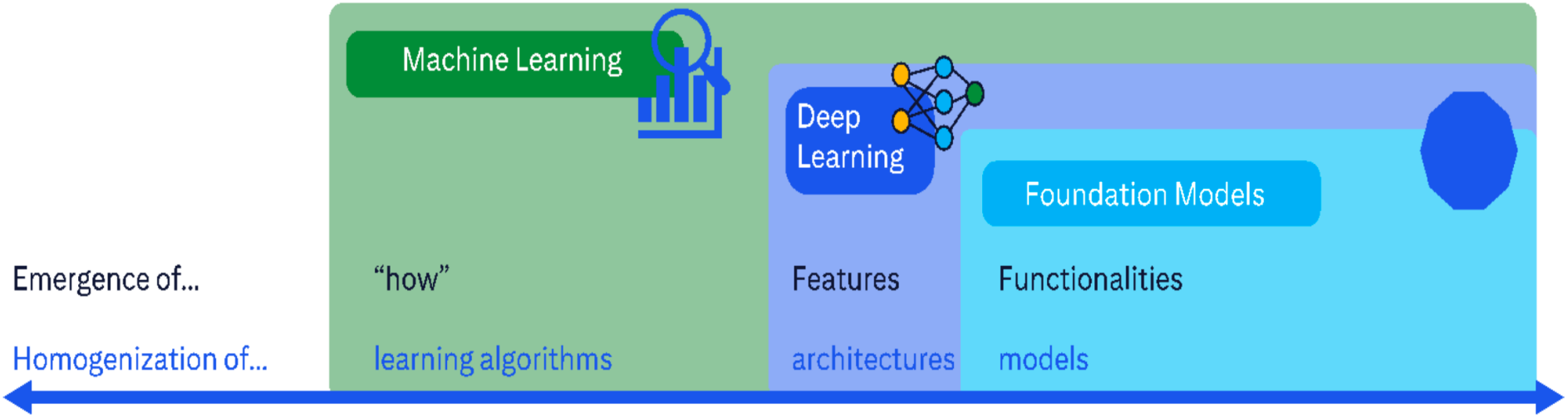
深圳市智能机器人应用示范典型案例

- https://gxj.sz.gov.cn/attachment/1/1721/1721278/12833537.pdf

2023: Generative AI's breakout year

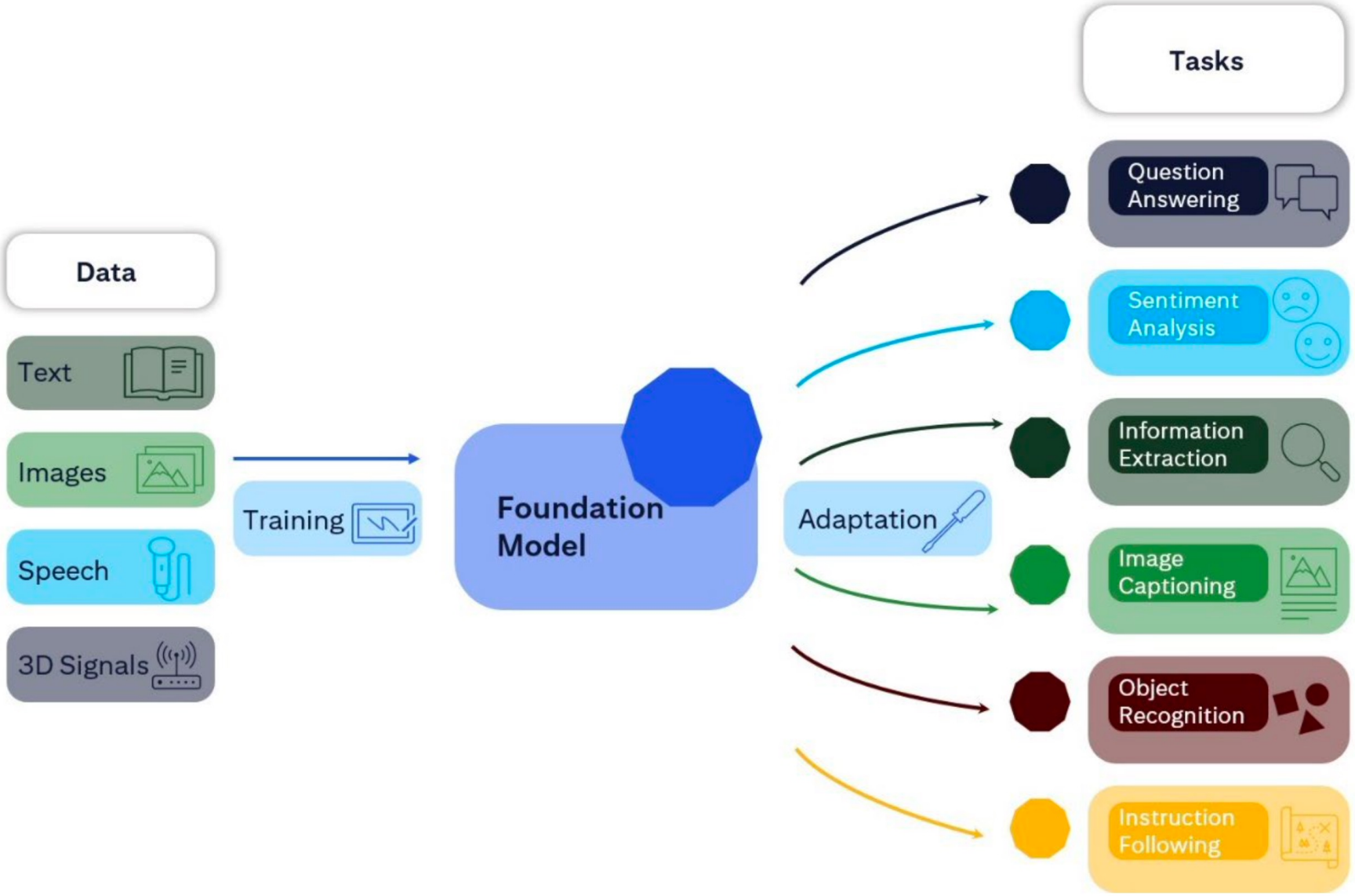
- Known as "the Year of Robot Awakening."
- The integration of foundation models, and the humanoid robotics industry has ushered in the era of embodied intelligence。

Figure 5. The Story of AI Has Been One of Increasing Emergence and Homogenization



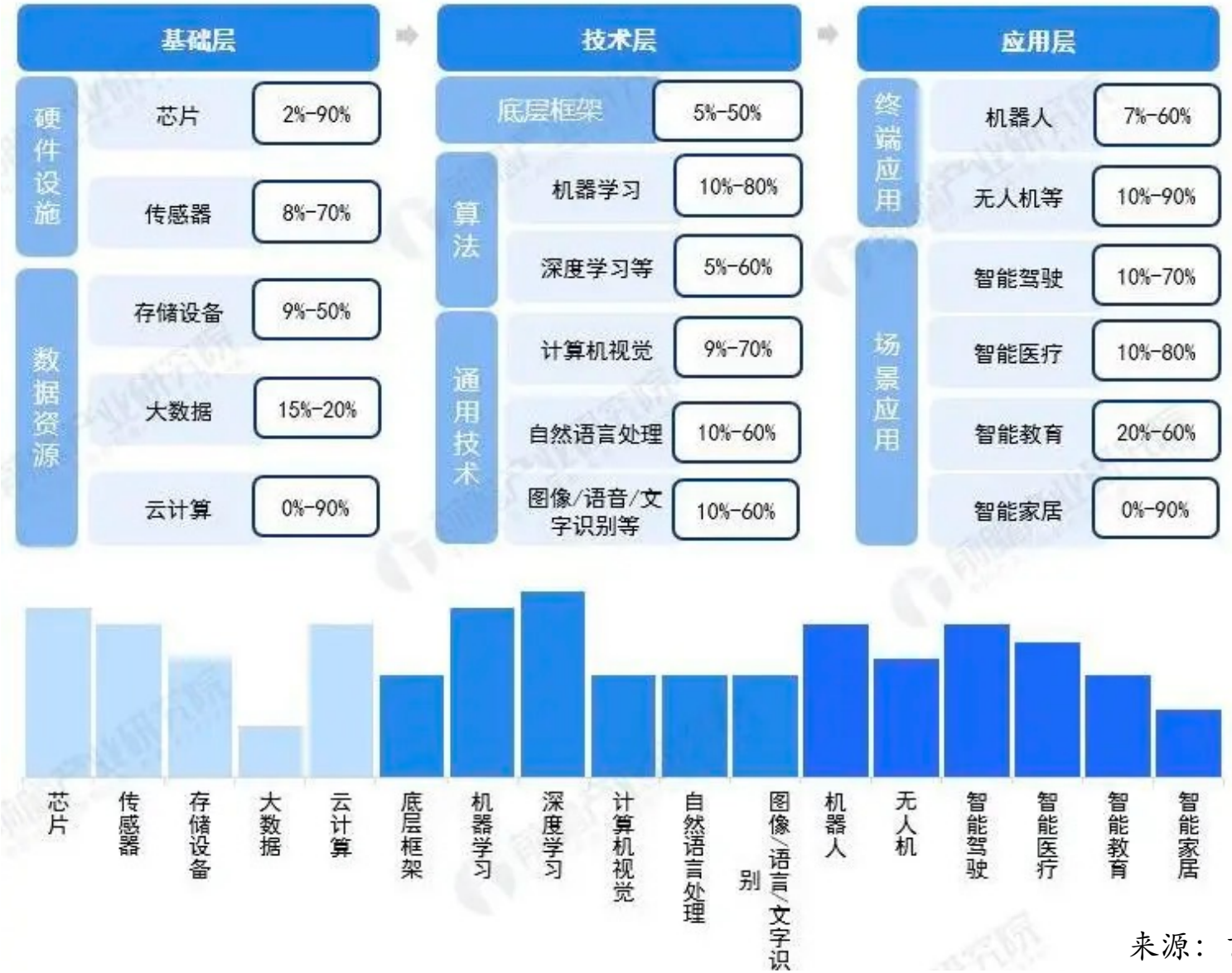
Source: On the Opportunities and Risks of Foundation Models

Figure 6. The Story of AI Has Been One of Increasing Emergence and Homogenization



Source: On the Opportunities and Risks of Foundation Models

The AI Industry Chain in China



来源：前瞻产业研究院

Volunteer to present your paper review/ case study

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Thank you~

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