

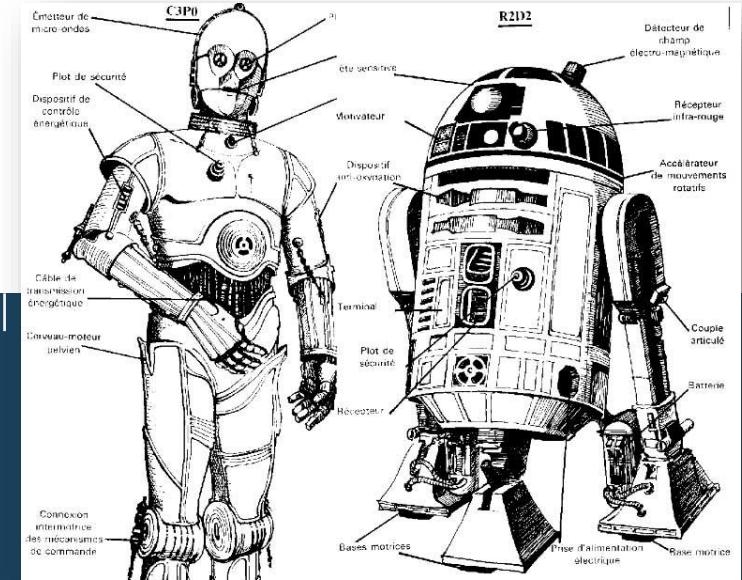


POLITECNICO
MILANO 1863

Robotics

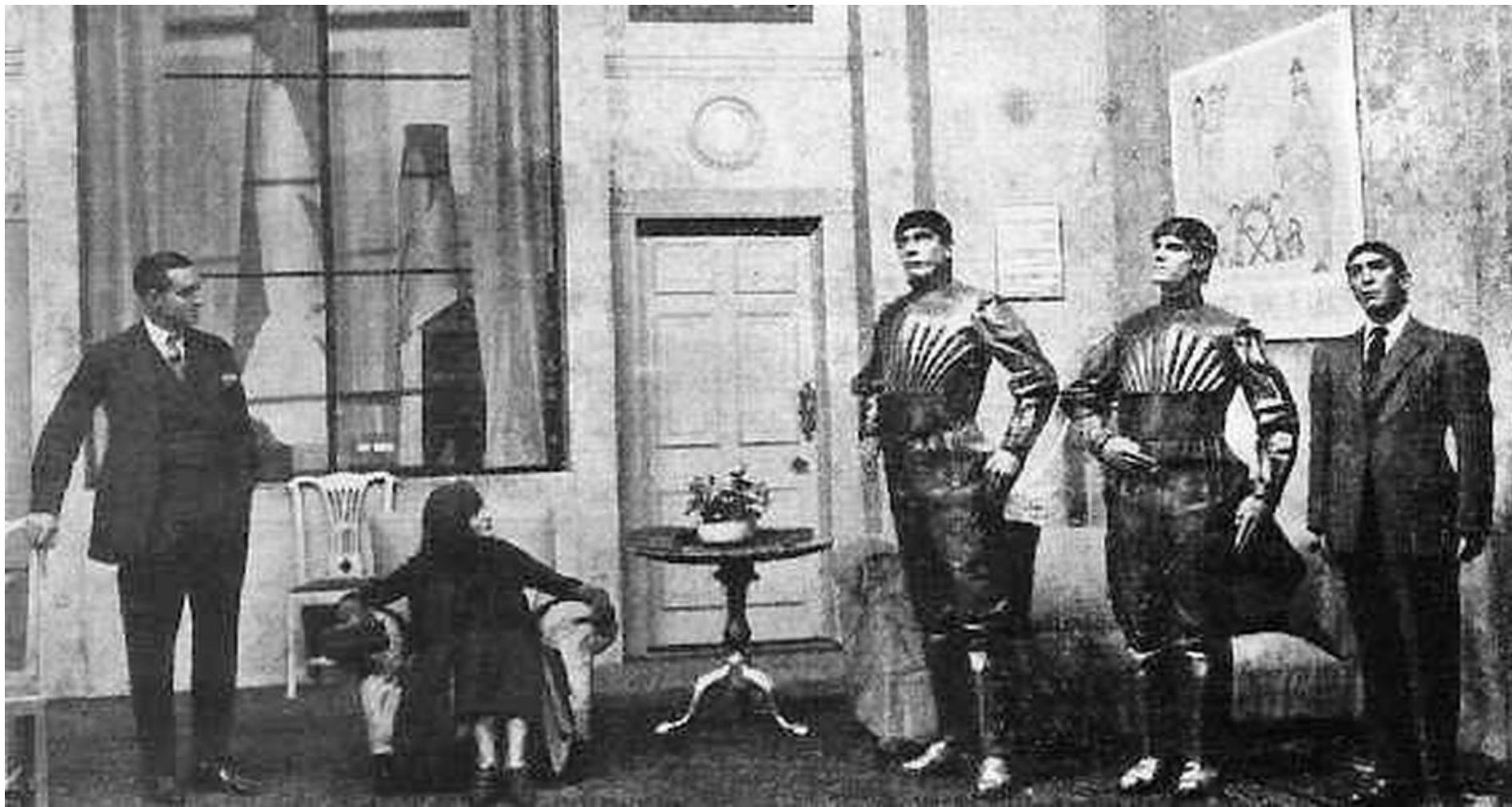
Introduction

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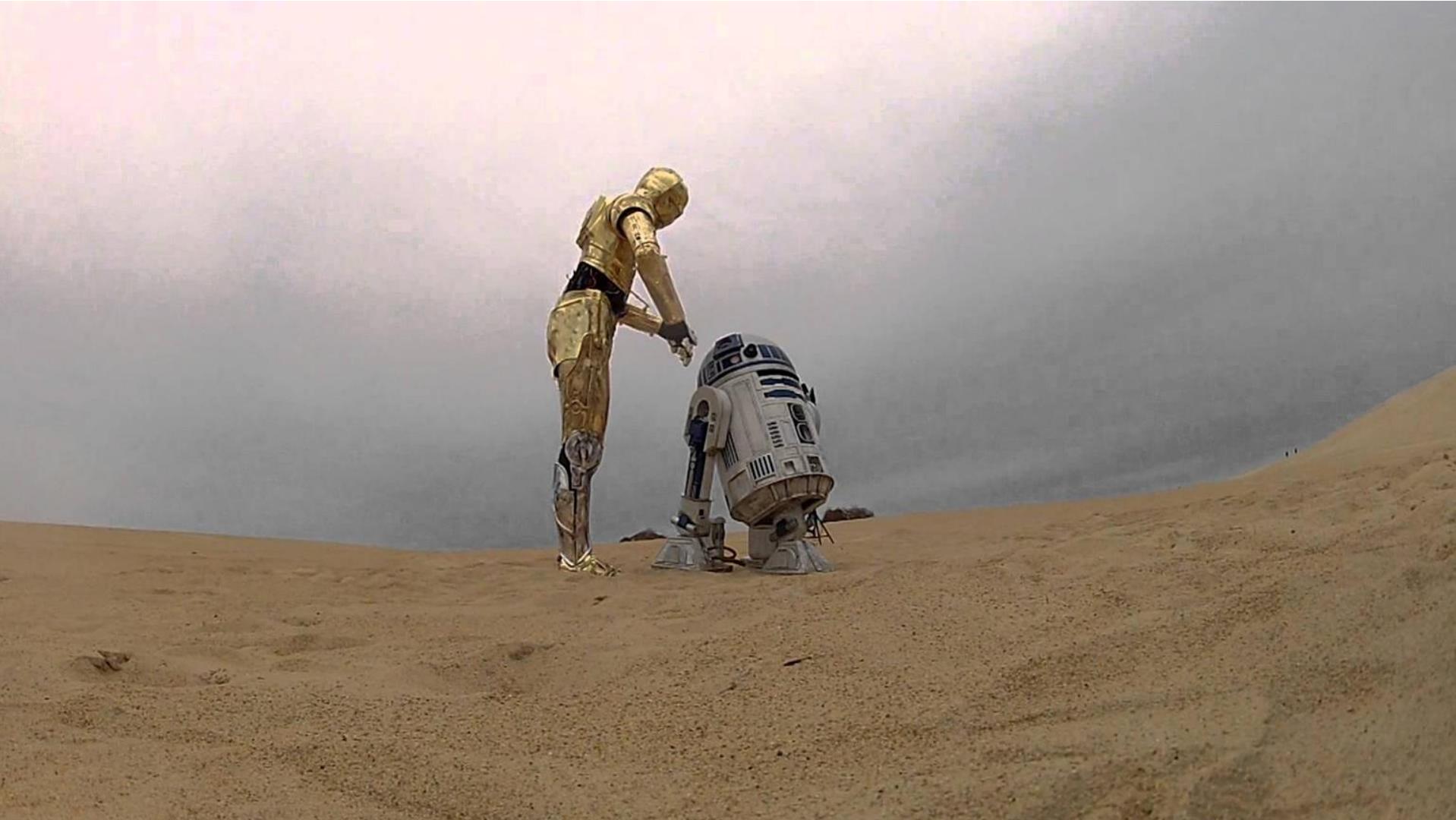


Artificial Intelligence and Robotics Lab - Politecnico di Milano

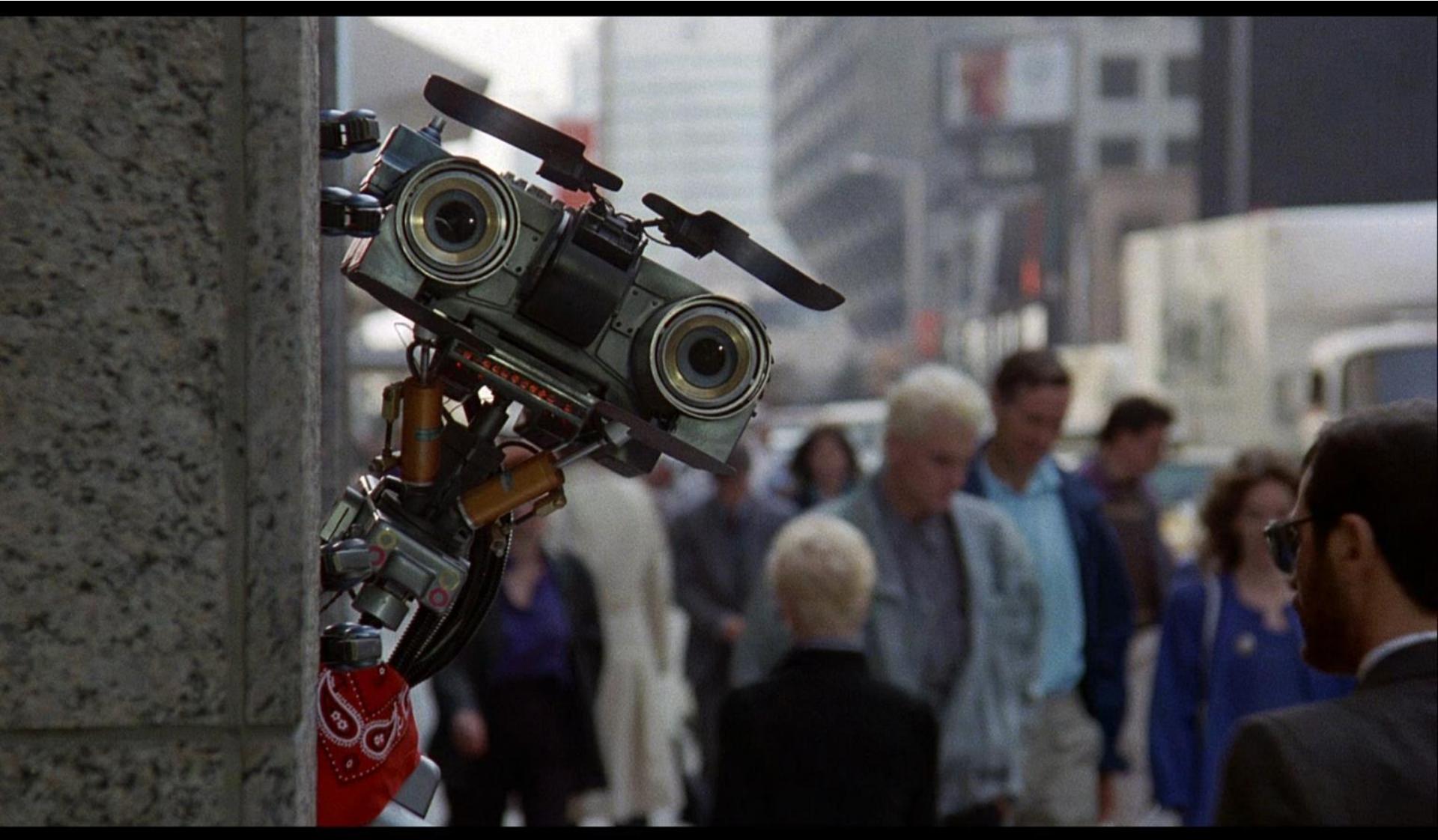
Rossum Universal Robots (1920)



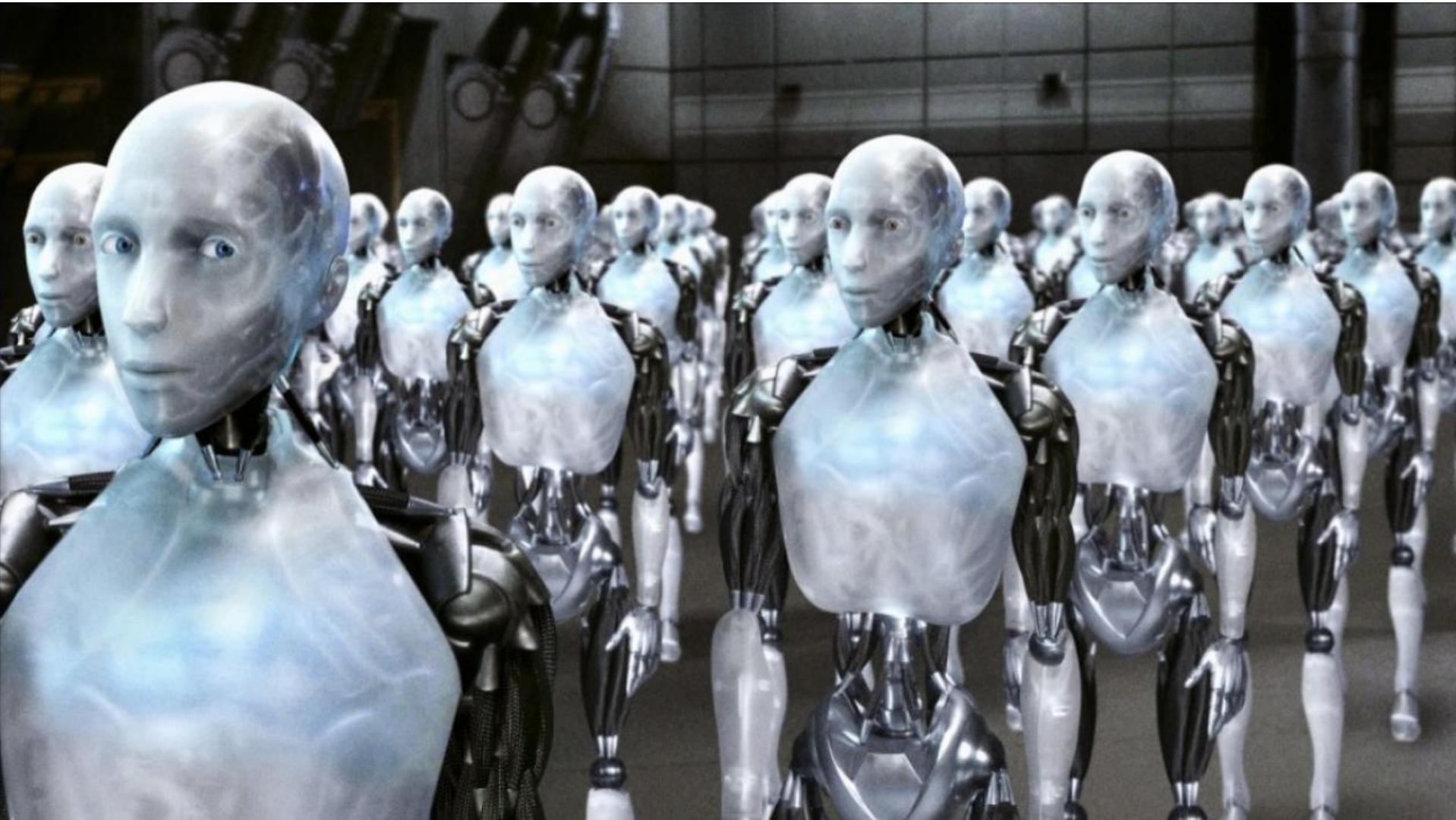
Star Wars (1977)



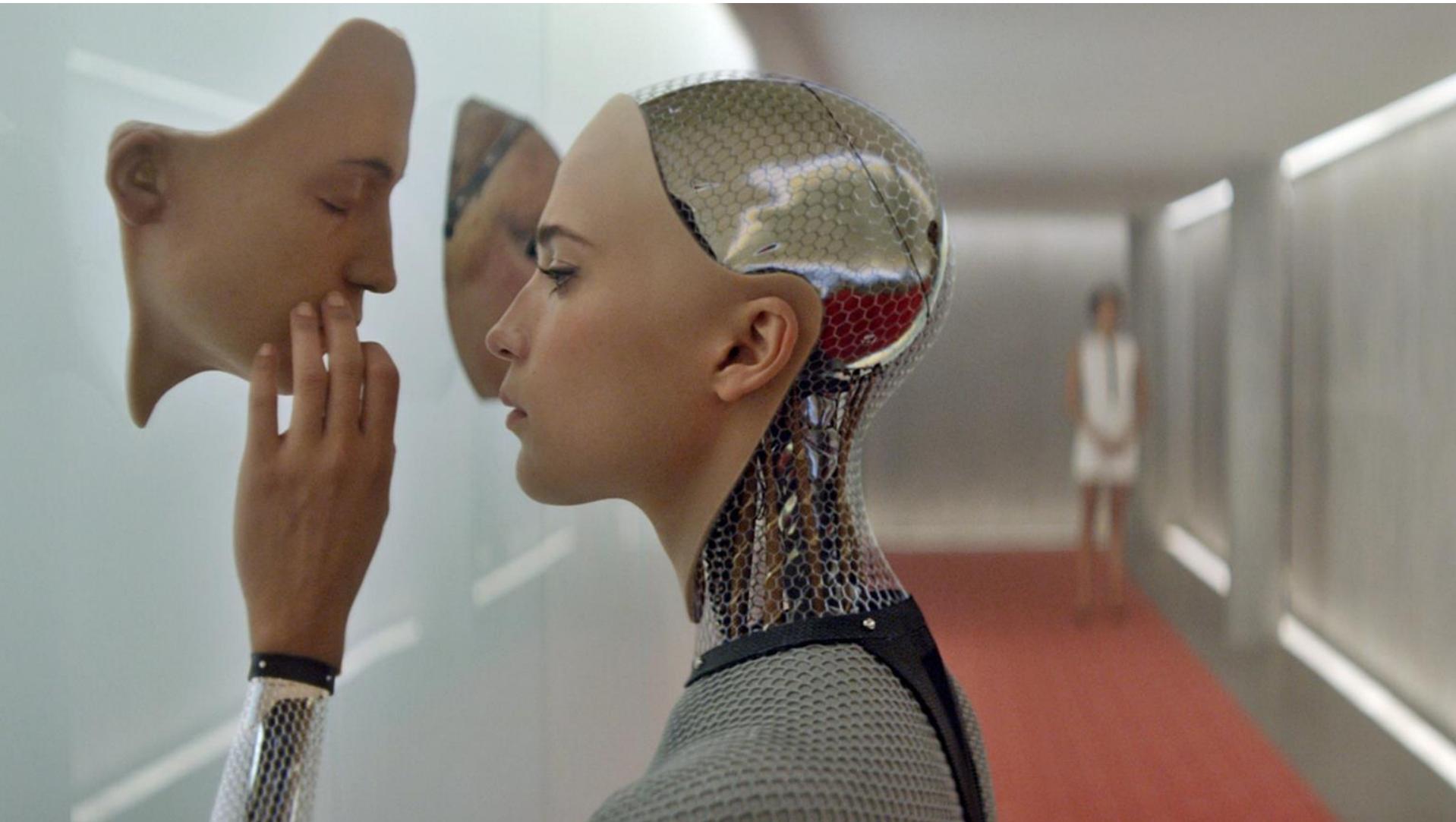
Short Circuit (1986)



I Robot (2001)



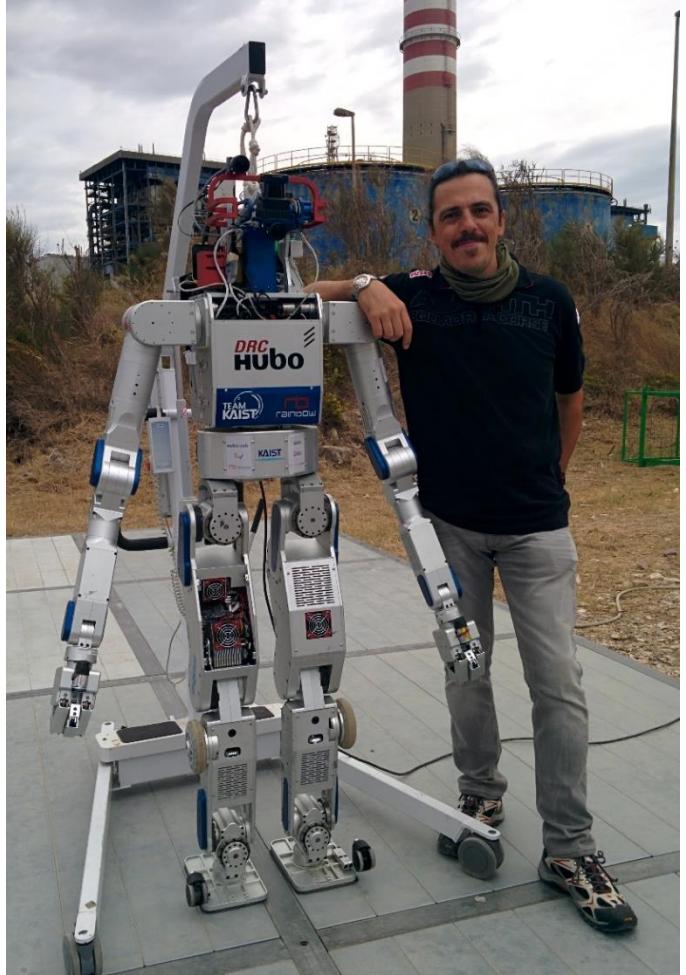
Ex Machina (2015)



Sometimes reality is different...



... and the winner is ...



... and check! Sometimes dreams come true (ATLAS 2016) ...



Boston Dynamics



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... and every year it gets better 😊



Boston Dynamics



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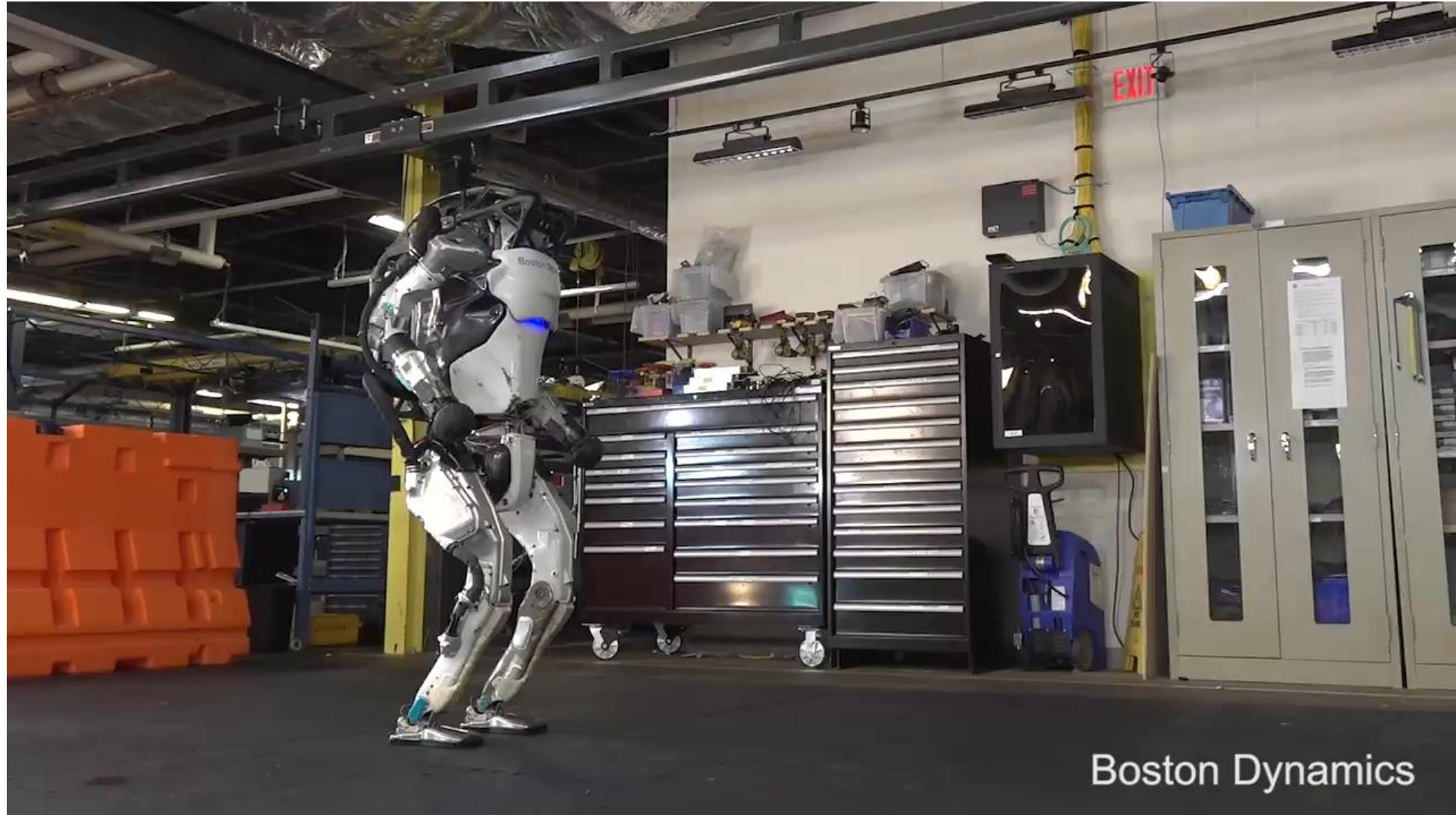
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... and better 😊



... and better 😊



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Status in 2024



Convergence with AI



Steps in robot history

Mechanical era (1700):

- automata
- karakuri-ningyo



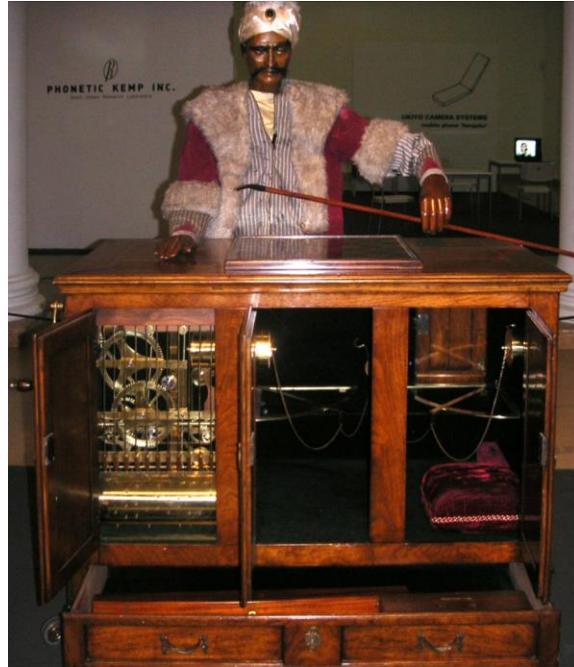
Automata: the robot ancestors



Karakuri-ningyo
Edo Period
(1603 – 1868)



The Writer
Pierre Jaquet-Droz
(1721-1790)



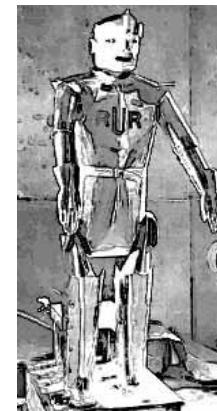
The Turk
Wolfgang von Kempelen
(1734 – 1804)



Steps in robot history

Mechanical era (1700):

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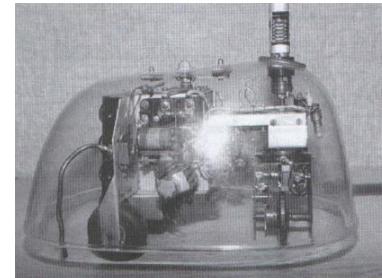


Fiction era ('20s):

- *Rossum Universal Robot*

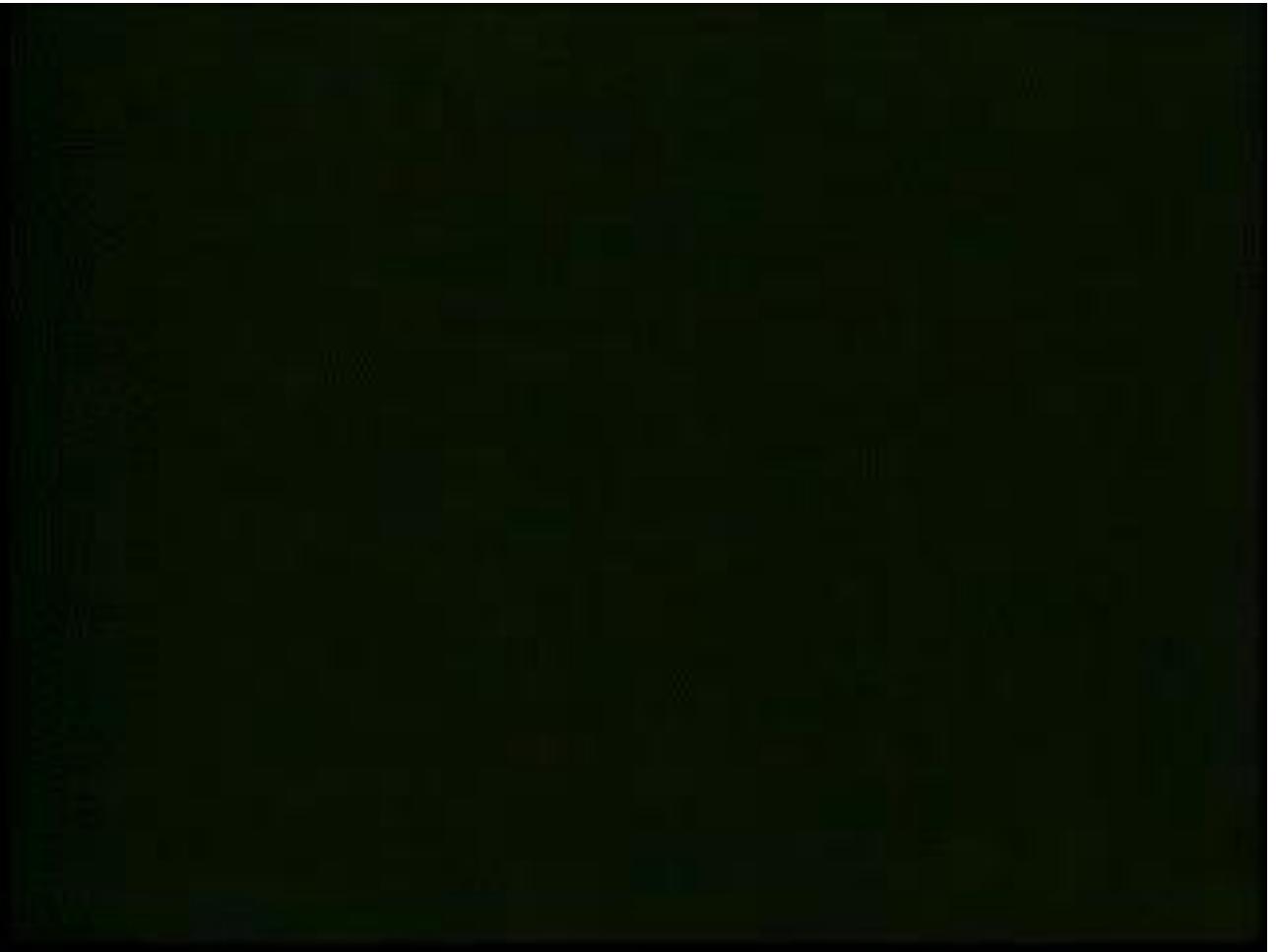
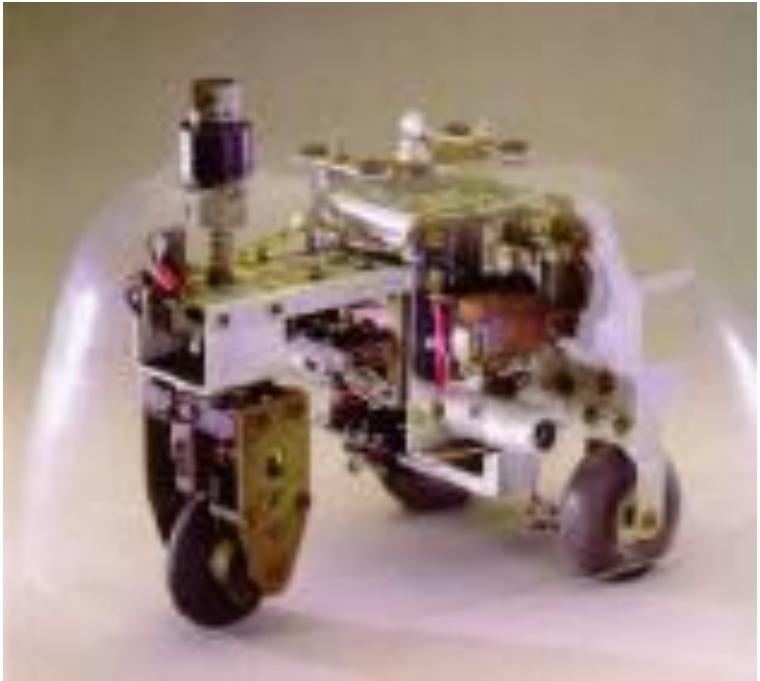
Cybernetics era ('40s):

- Turtle and telerobot



Early «robot» experiments

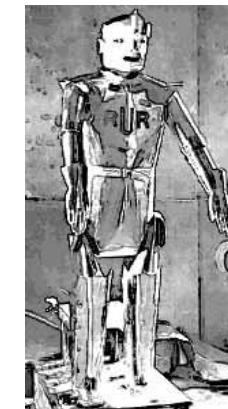
Grey Walter's tortoises ('50s):
mechanical plausibility of animal
tropism. (Tropism/taxis: animal
movement directed by stimuli).



Steps in robot history

Mechanical era (1700):

- automata
- karakuri-ningyo

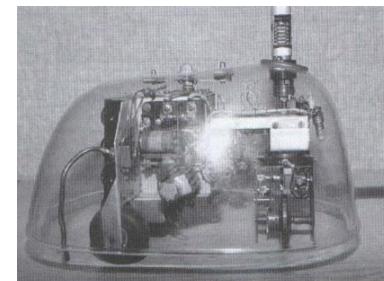


Fiction era ('20s):

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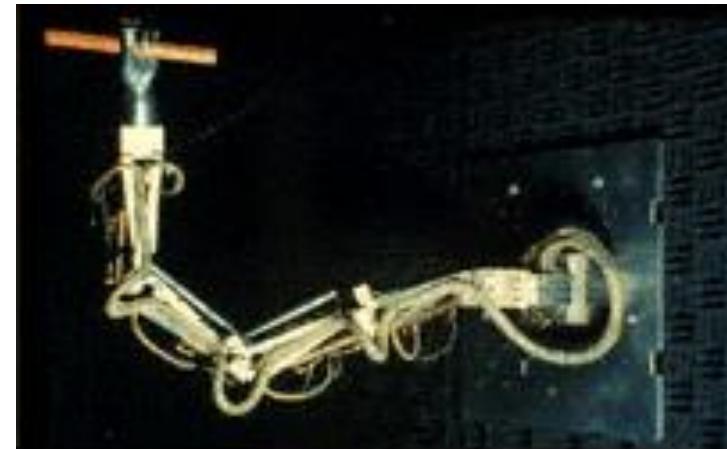
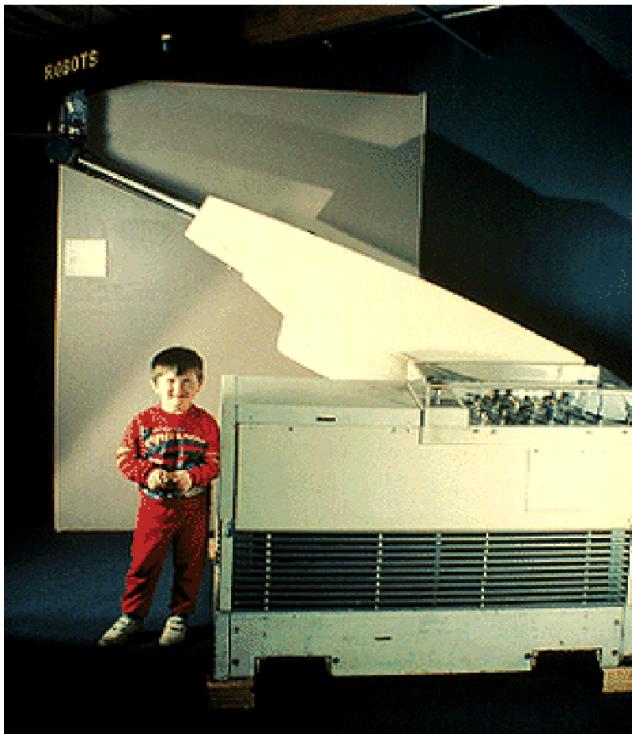
Automation era (from the '60s):

- Industrial robots



First robots

1961 - UNIMATE, the first industrial robot, began work at General Motors. Obeying step-by-step commands stored on a magnetic drum, the 4,000-pound arm sequenced and stacked hot pieces of die-cast metal.



1968 - Marvin Minsky developed the Tentacle Arm, which moved like an octopus. It had twelve joints designed to reach around obstacles. A PDP-6 computer controlled the arm, powered by hydraulic fluids. Mounted on a wall, it could lift the weight of a person.



What is a Robot?

A reprogrammable, multifunctional manipulator designed to move material, parts, tools, or specialized devices through various programmed motions for the performance of a variety of tasks.

(Robot Institute of America, 1980)



An what about these???

We need a different defintion of robot!



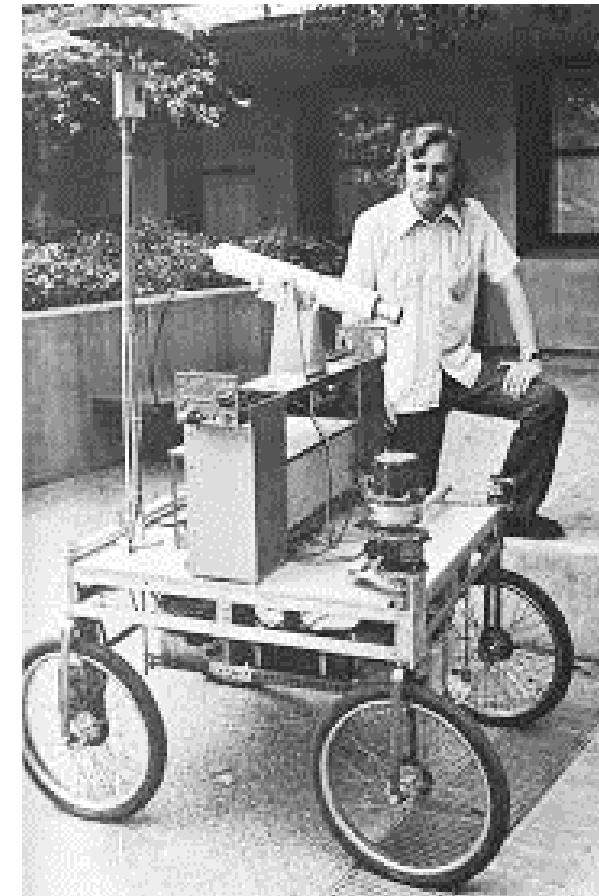
3D Robotics

jibo

STARSHIP



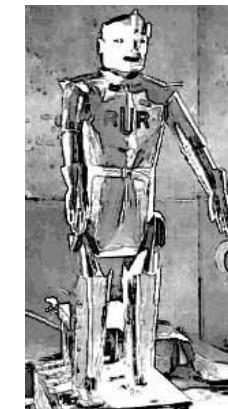
Shakey (1972) and the Stanford Cart (1970)



Steps in robot history

Mechanical era (1700):

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- karakuri-ningyo

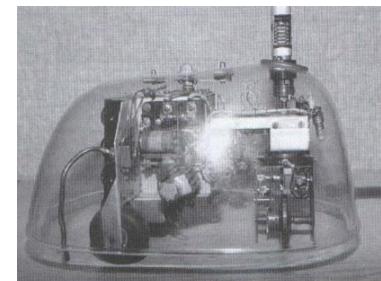


Fiction era ('20s):

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Cybernetics era ('40s):

- Turtle and telerobot



Automation era (from the '60s):

- Industrial robots



Information era (from the '90s):

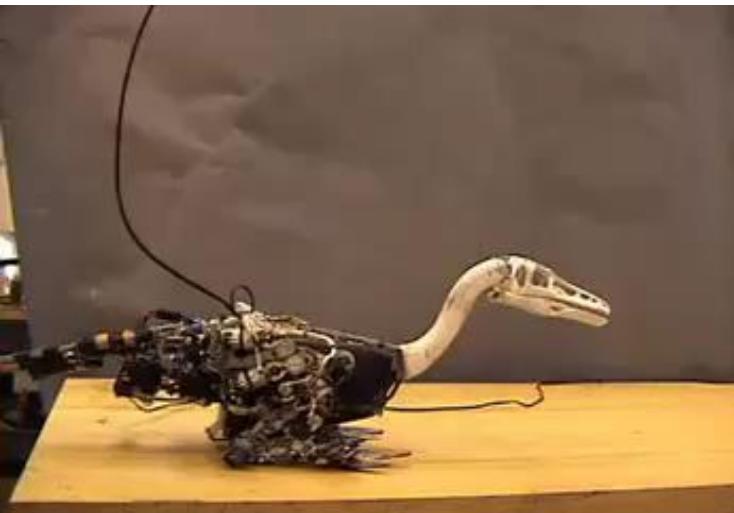
- Intelligence
- Autonomy
- Cooperation



- ✓ A robot is an actuated mechanism programmable in two or more axes with a degree of autonomy, moving within its environment, to perform intended tasks. Autonomy in this context means the ability to perform intended tasks based on current state and sensing, without human intervention.
- ✓ A service robot is a robot that performs useful tasks for humans or equipment excluding industrial automation application.



Autonomous service robot



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- ✓ A service robot is a robot that performs useful tasks for humans or equipment excluding industrial automation application.
- ✓ A personal service robot or a service robot for personal use is a service robot used for a non-commercial task, usually by lay persons. E.g., domestic servant robot, automated wheelchair, personal mobility assist robot, and pet exercising robot.

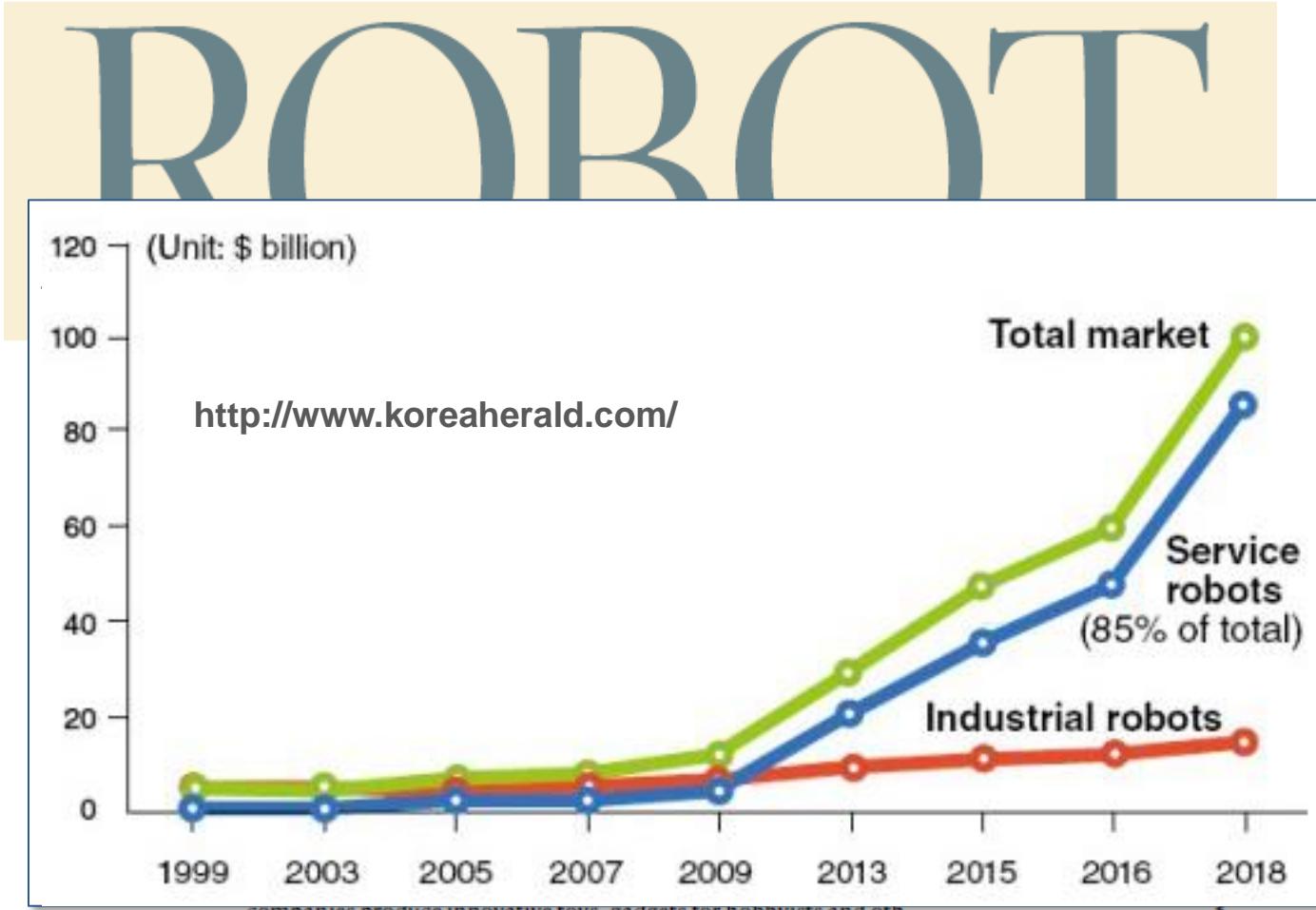


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- ✓ A professional service robot or a service robot for professional use is a service robot used for a commercial task, usually operated by a properly trained operator. E.g., cleaning robot for public places, delivery robot in offices or hospitals, fire-fighting robot, rehabilitation robot and surgery robot in hospitals. In this context an operator is a person designated to start, monitor and stop the intended operation of a robot or a robot system.



The Bill Gates “Prophecy” ...

A



- ✓ A robot system is a system comprising robot(s), end-effector(s) and any machinery, equipment, or sensors supporting the robot performing its task.
- ✓ According to the definition, "a degree of autonomy" is required for service robots ranging from partial autonomy (including human robot interaction) to full autonomy (without active human robot intervention). In this context human robot-interaction means information and action exchanges between human and robot to perform a task by means of a user interface.



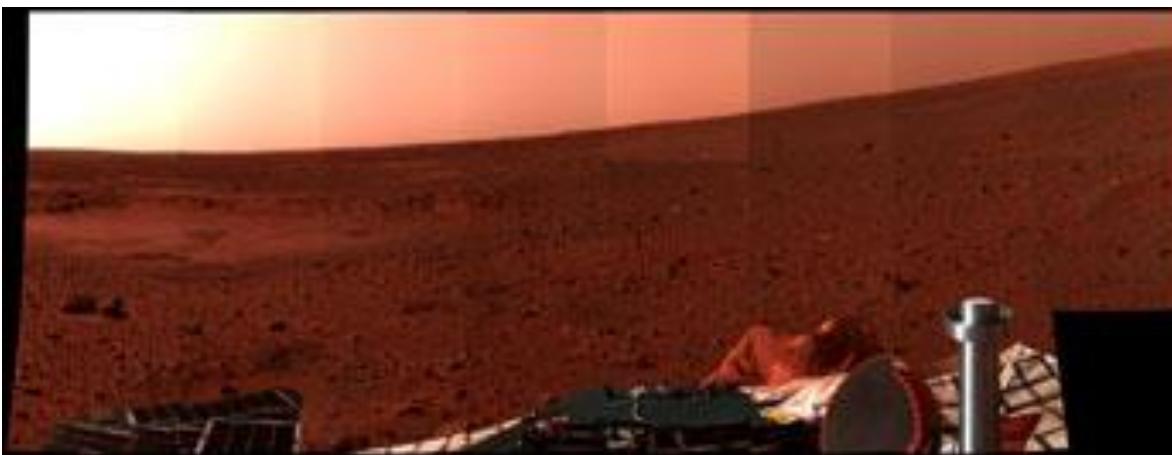
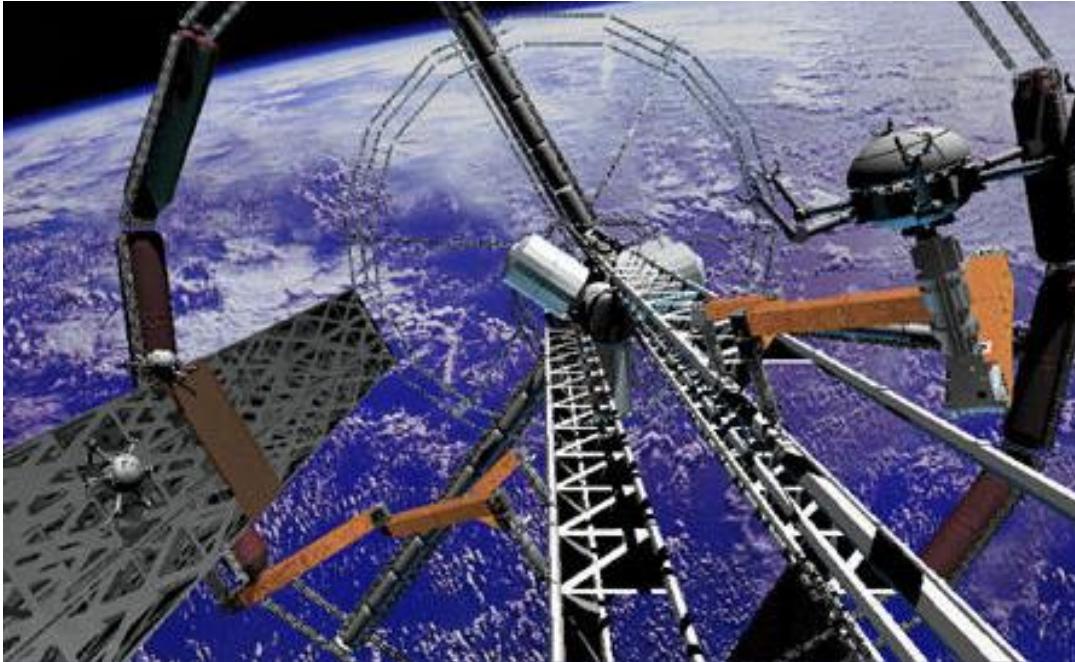
Medical robots



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- ✓ Manipulating industrial robots (which can be either fixed in place or mobile) could also be regarded as service robots, provided they are installed in non-manufacturing operations. Service robots may or may not be equipped with an arm structure as is case with some industrial robots. Often, but not always, service robots are mobile.



Space robots



Autonomous vehicles



The Race to Market

Traffic Ahead

Many carmakers are developing prototype vehicles that are capable of driving autonomously in certain situations. The technology is likely to hit the road around 2020.



BMW



Mercedes-Benz



Nissan



Google



General Motors

VEHICLE	BMW 5 Series (modified)	Mercedes-Benz S 500 Intelligent Drive Research Vehicle	Nissan Leaf EV (modified)	Google Prius and Lexus (modified)	General Motors Cadillac SRX (modified)
KEY TECHNOLOGIES	<ul style="list-style-type: none">Video camera tracks lane markings and reads road signsRadar sensors detect objects aheadSide laser scannersUltrasonic sensorsDifferential GPSVery accurate map	<ul style="list-style-type: none">Stereo camera sees objects ahead in 3-DAdditional cameras read road signs and detect traffic lightsShort- and long-range radarInfrared cameraUltrasonic sensors	<ul style="list-style-type: none">Front and side radarCameraFront, rear, and side laser scannersFour wide-angle cameras show the driver the car's surroundings	<ul style="list-style-type: none">LIDAR on the roof detects objects around the car in 3-DCamera helps detect objectsFront and side radarInertial measuring unit tracks positionWheel encoder tracks movementVery accurate map	<ul style="list-style-type: none">Several laser sensorsRadarDifferential GPSCamerasVery accurate map



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- ✓ In some cases, service robots consist of a mobile platform on which one or several arms are attached and controlled in the same mode as the arms of industrial robot. Furthermore, contrary to their industrial counterparts, service robots do not have to be fully automatic or autonomous. In many cases these machines may even assist a human user or be tele-operated.

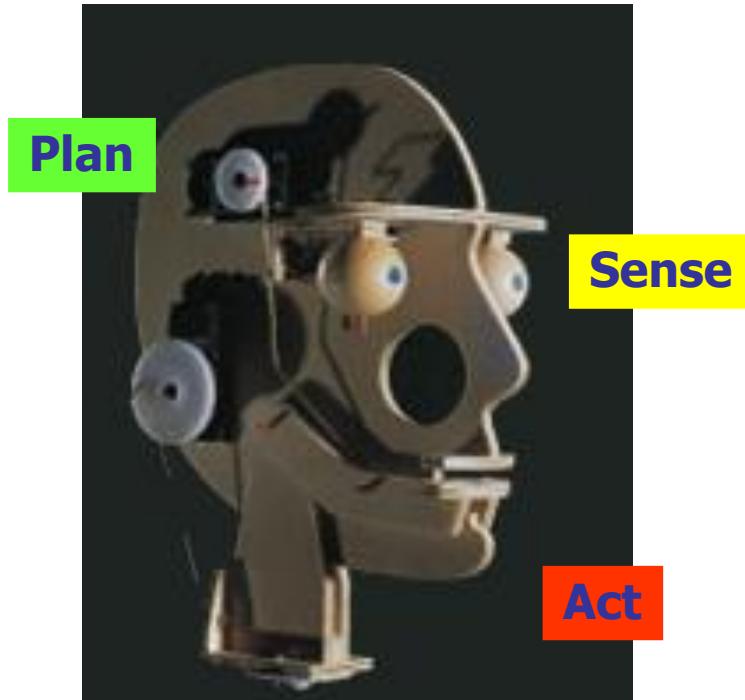


Teleoperated and telepresence robots



What makes an autonomous robot?

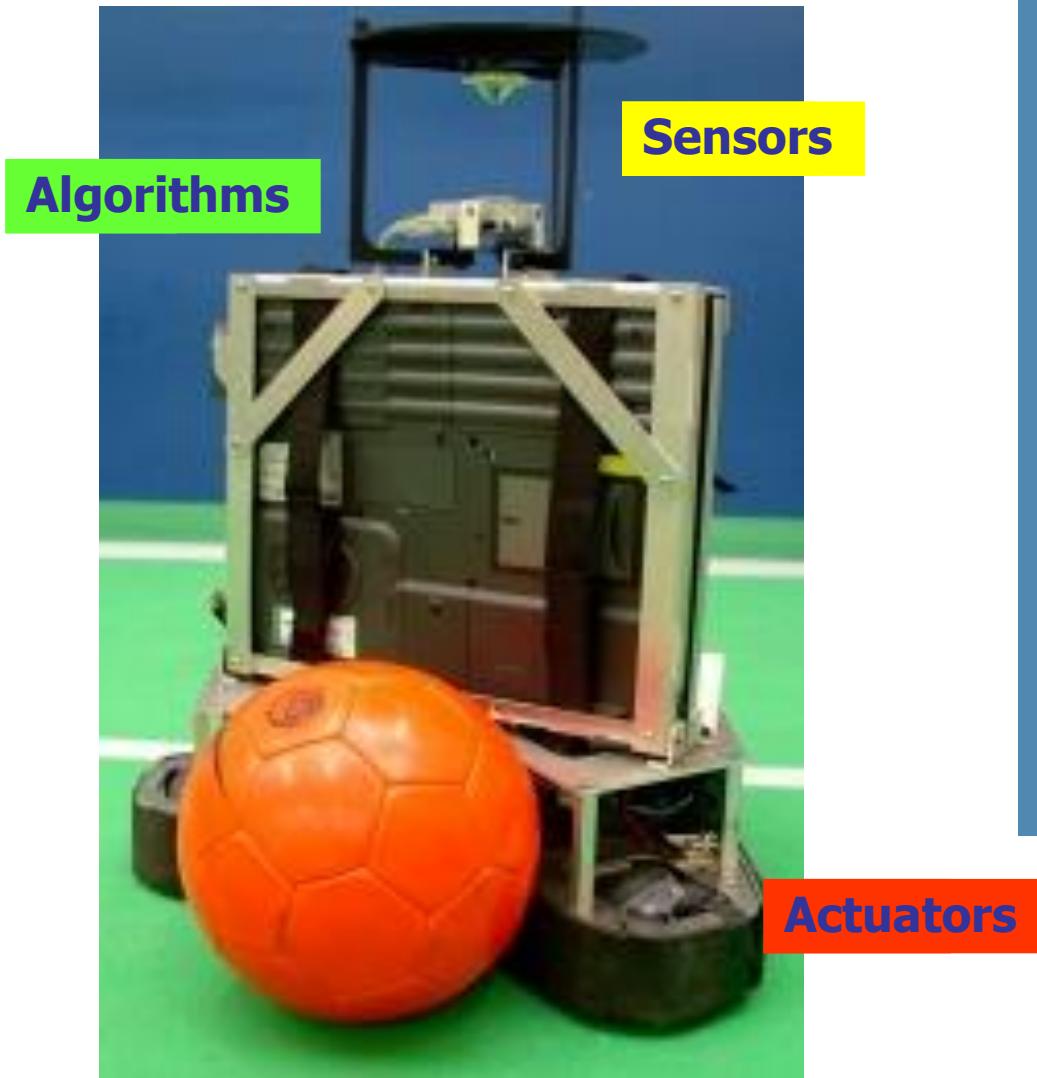
A machine gets information from a set of sensors and upon these accomplish its task autonomously by moving its body parts ...



Note: The Sense-Plan-Act model is just one possible cognitive architecture for autonomous robots (Cognitive Robotics)



What does it make a mobile robot?



A Simplified Sense-Plan-Act Architecture

