Class 01 | Lecture
Introduction to Robots

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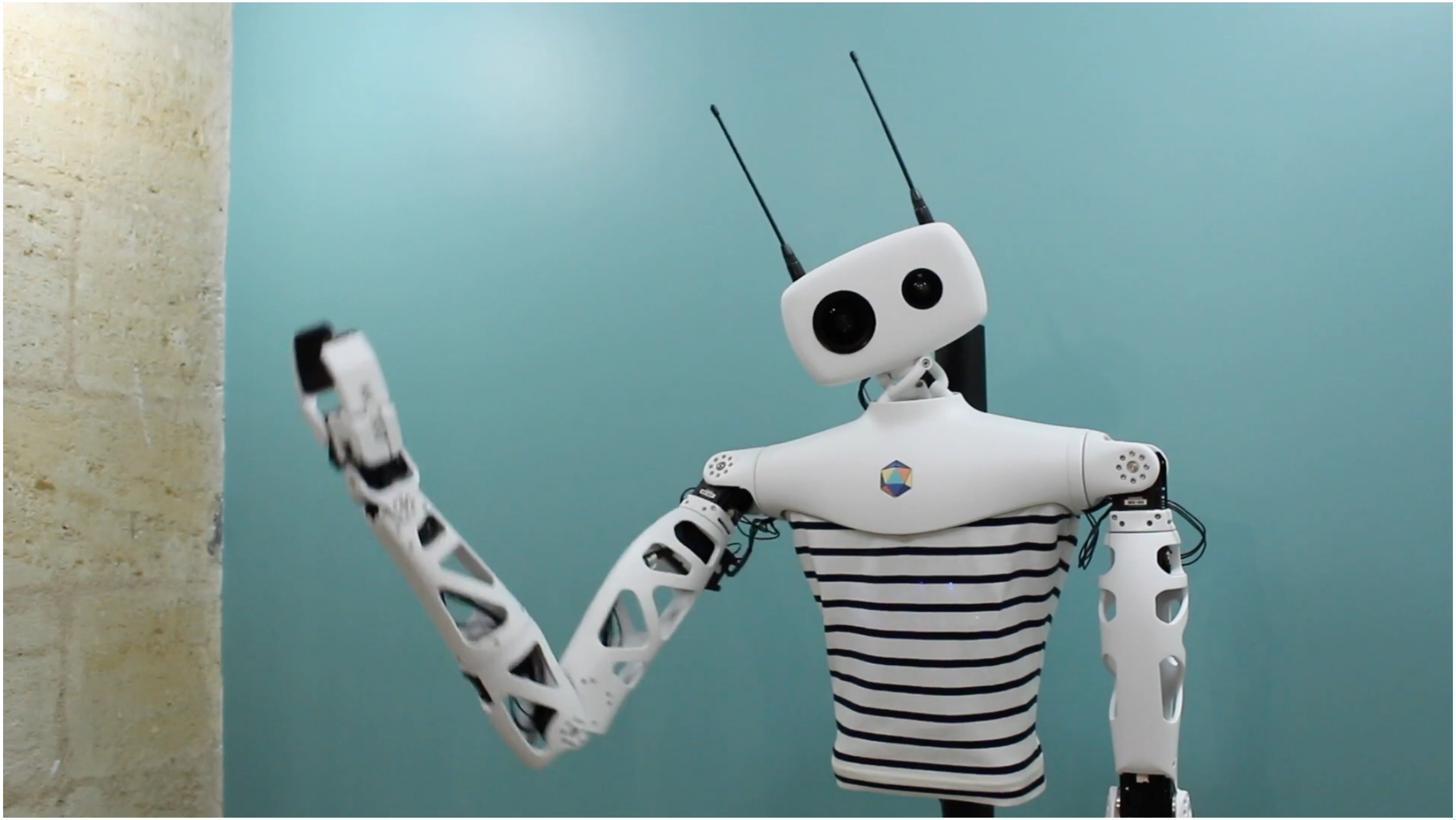
Robot of the Day

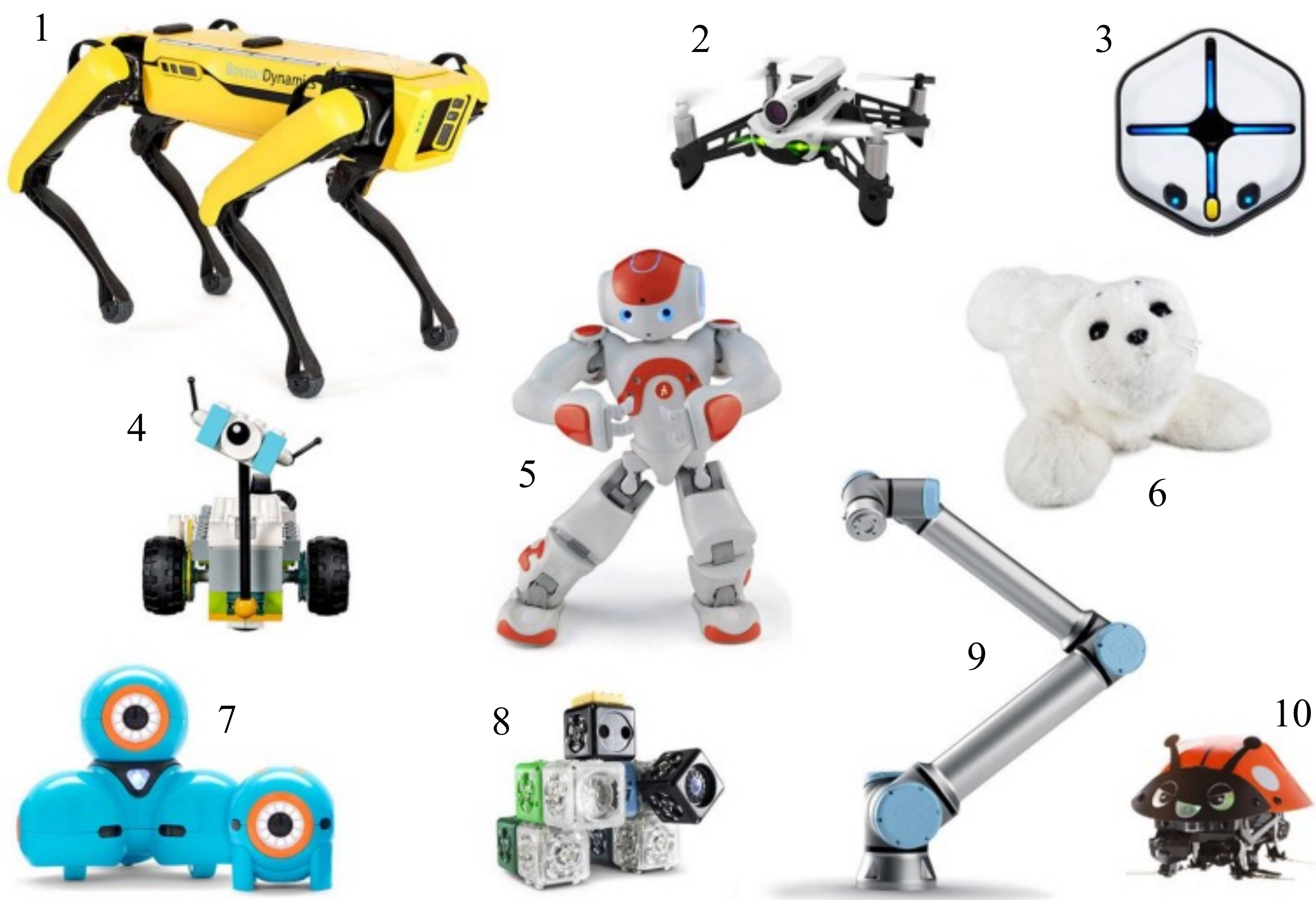


Reachy by Pollen Robotics

Introduction to Robots

- Type of Robots
  - by Concepts / Applications / Kinematics
- Define Robots
  - Sense, Plan, and Act
- The Human Side
  - Collaboration and Social Characteristics

Which one do you like the most, and why?



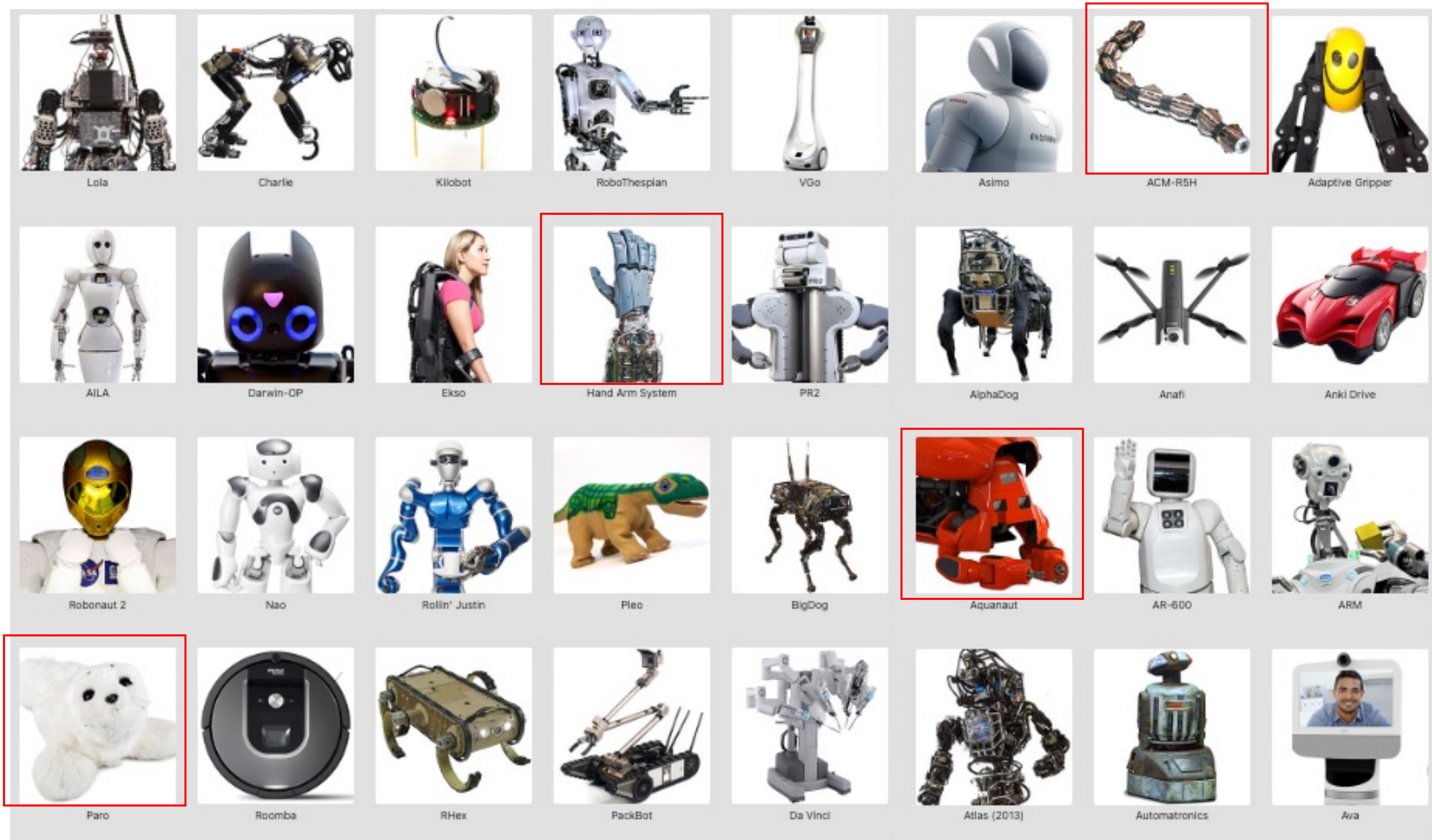
Types

- It’s not easy to define what robots are, and it’s not easy to categorize them either.
  - Each robot has its own unique features
  - Robots vary hugely in size, shape, and capabilities
  - Still, many robots share a variety of features

- A General Classification by Concepts
- A Utility Classification by Applications
- A Technical Classification by Kinematics

Classification by Concepts (https://robots.ieee.org/robots/)

A Library of Robots



Types of Robots

Designed with familar concepts to your daily lives

Humanoids: This is probably the type of robot that most people think of when they think of a robot. Examples of humanoid robots include Honda's Asimo, which has a mechanical appearance, and also androids like the Geminoid series, which are designed to look like people.

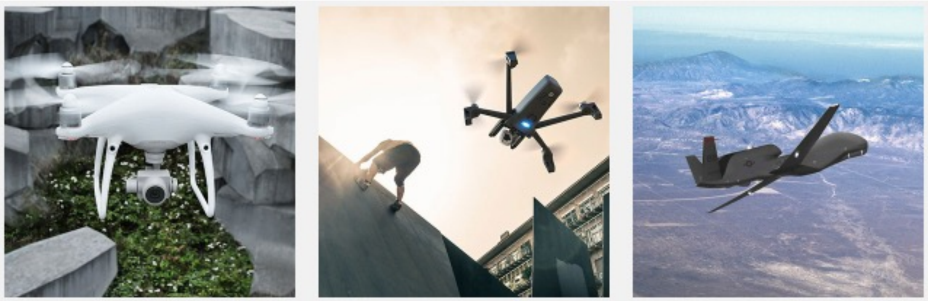
Entertainment: These robots are designed to evoke an emotional response and make us laugh or feel surprise or in awe. Among them are robot comedian RoboThespian, Disney's theme park robots like Navi Shaman, and musically inclined bots like Partner.

Consumer: Consumer robots are robots you can buy and use just for fun or to help you with tasks and chores. Examples are the robot dog Aibo, the Roomba vacuum, AI-powered robot assistants, and a growing variety of robotic toys and kits.

Education: This broad category is aimed at the next generation of roboticists, for use at home or in classrooms. It includes hands-on programmable sets from Lego, 3D printers with lesson plans, and even teacher robots like EMYS.

Types of Robots

Designed with advanced modes of mobility



Drones: Also called unmanned aerial vehicles, drones come in different sizes and have different levels of autonomy. Examples include DJI's popular Phantom series and Parrot's Anafi, as well as military systems like Global Hawk, used for long-duration surveillance.

Telepresence: Telepresence robots allow you to be present at a place without actually going there. You log on to a robot avatar via the internet and drive it around, seeing what it sees, and talking with people. Workers can use it to collaborate with colleagues at a distant office, and doctors can use it to check on patients.

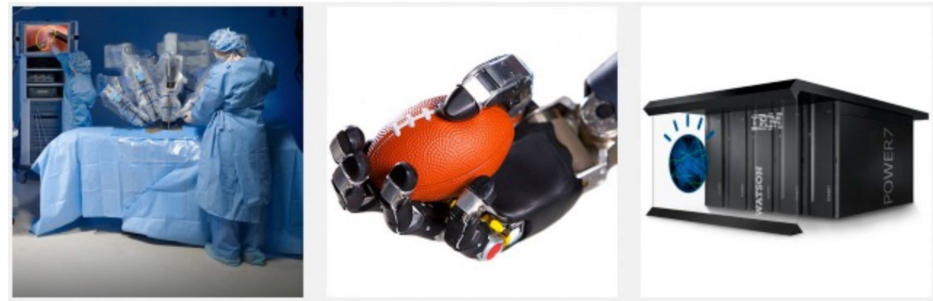
Self-Driving Cars: Many robots can drive themselves around, and an increasing number of them can now drive *you* around. Early autonomous vehicles include the ones built for DARPA's autonomous-vehicle competitions and also Google's pioneering self-driving Toyota Prius, later spun out to form Waymo.

Exoskeletons: Robotic exoskeletons can be used for physical rehabilitation and for enabling a paralyzed patient walk again. Some have industrial or military applications, by giving the wearer added mobility, endurance, or capacity to carry heavy loads.

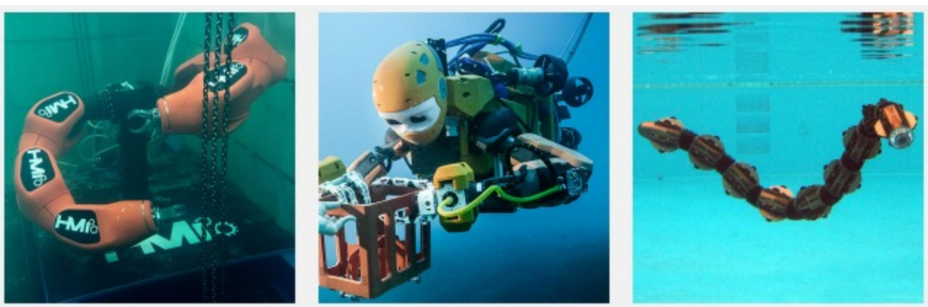
Types of Robots

Designed for applications in specialized environment

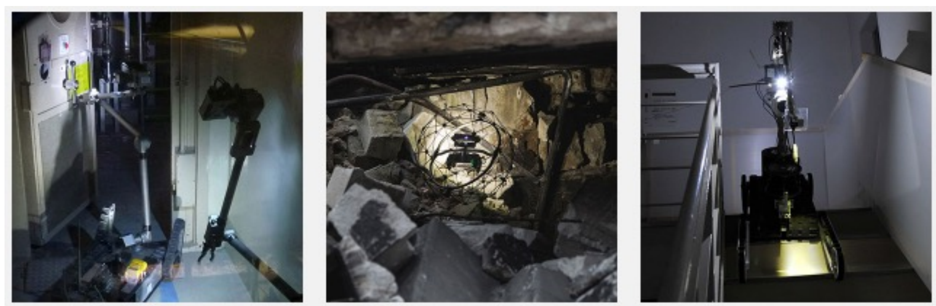
Industrial: The traditional industrial robot consists of a manipulator arm designed to perform repetitive tasks. An example is the Unimate, the grandfather of all factory robots. This category includes also systems like Amazon's warehouse robots and collaborative factory robots that can operate alongside human workers.



Medical: Medical and health-care robots include systems such as the da Vinci surgical robot and bionic prostheses, as well as robotic exoskeletons. A system that may fit in this category but is not a robot is Watson, the IBM question-answering supercomputer, which has been used in healthcare applications.



Underwater: The favorite place for these robots is in the water. They consist of deep-sea submersibles like Aquanaut, diving humanoids like Ocean One, and bio-inspired systems like the ACM-R5H snakebot.



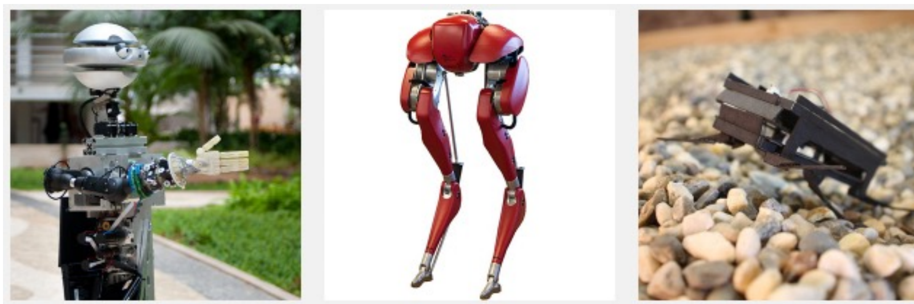
Disaster Response: These robots perform dangerous jobs like searching for survivors in the aftermath of an emergency. For example, after an earthquake and tsunami struck Japan in 2011, Packbots were used to inspect damage at the Fukushima Daiichi nuclear power station.

Types of Robots

Designed for advanced human-robot interaction

Aerospace: This is a broad category. It includes all sorts of flying robots—the SmartBird robotic seagull and the Raven surveillance drone, for example—but also robots that can operate in space, such as Mars rovers and NASA's Robonaut, the humanoid that flew to the International Space Station and is now back on Earth.

Military & Security: Military robots include ground systems like Endeavor Robotics' PackBot, used in Iraq and Afghanistan to scout for improvised explosive devices, and BigDog, designed to assist troops in carrying heavy gear. Security robots include autonomous mobile systems such as Cobalt.



Research: The vast majority of today's robots are born in universities and corporate research labs. Though these robots may be able to do useful things, they're primarily intended to help researchers do, well, research. So although some robots may fit other categories described here, they can also be called research

Common Designs of Robot @ Work

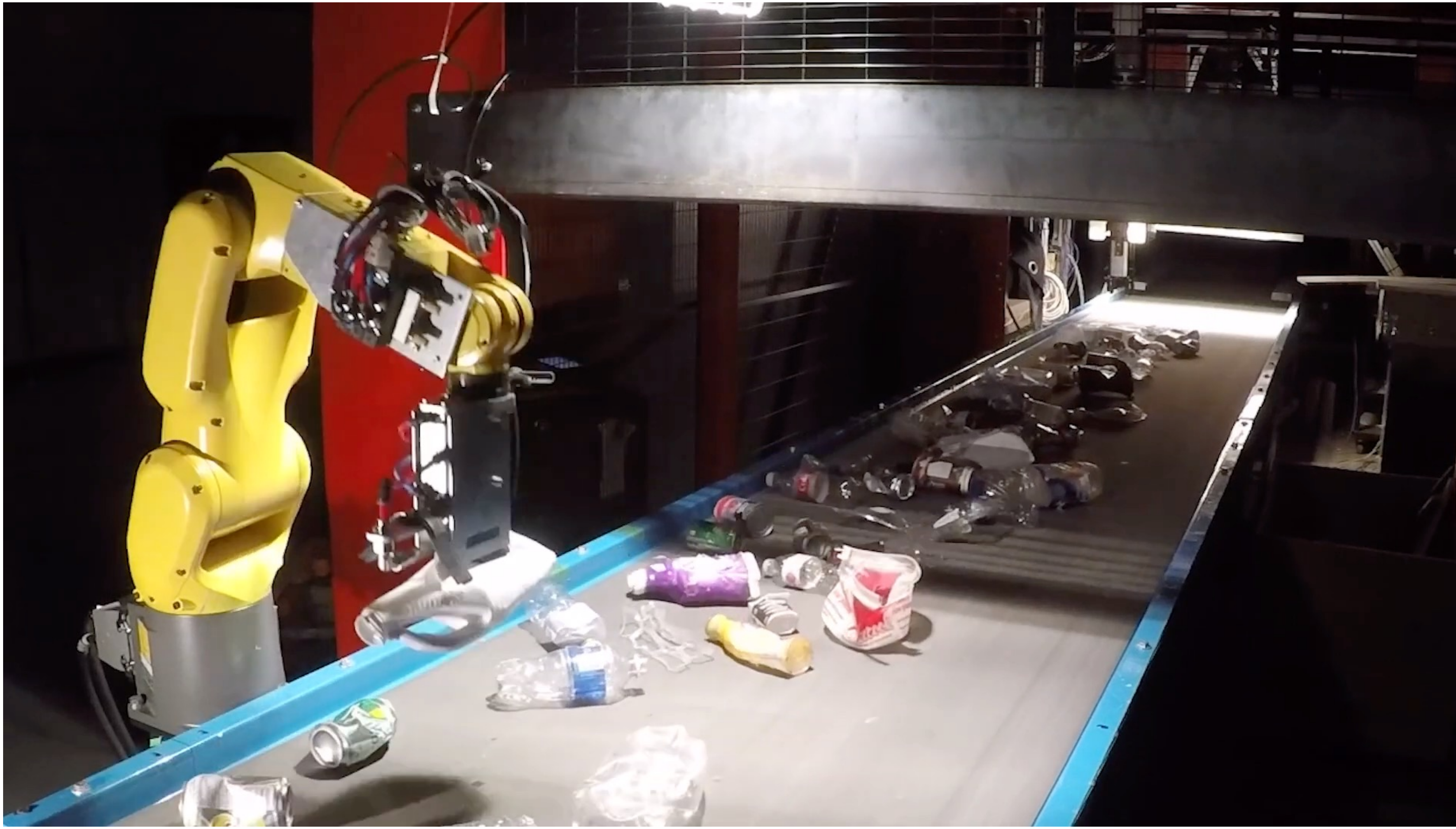
- **Articulated**
- **Cartesian**
- **Selective Compliance Assembly Robot Arm (SCARA)**
- **Delta**
- **Cylindrical**
- **Polar and more**

…

Articulated Robot

Features a rotary axis and can range from simple three-axis structures to 10 or more joints

- The manipulator connects to the base with a twisting joint.
- A rotary axis connects the links in the manipulator.
- Each axis provides an additional degree of freedom, or range of motion.



Cartesian Robot

Also called rectilinear or gantry robots

- Cartesian robots have three linear axes that use the Cartesian coordinate system (x, y and z).
- They may have an attached axis that enables rotational movement.
- Three prismatic joints facilitate linear motion along the axis.

SCARA

Selective Compliance Assembly Robot Arm

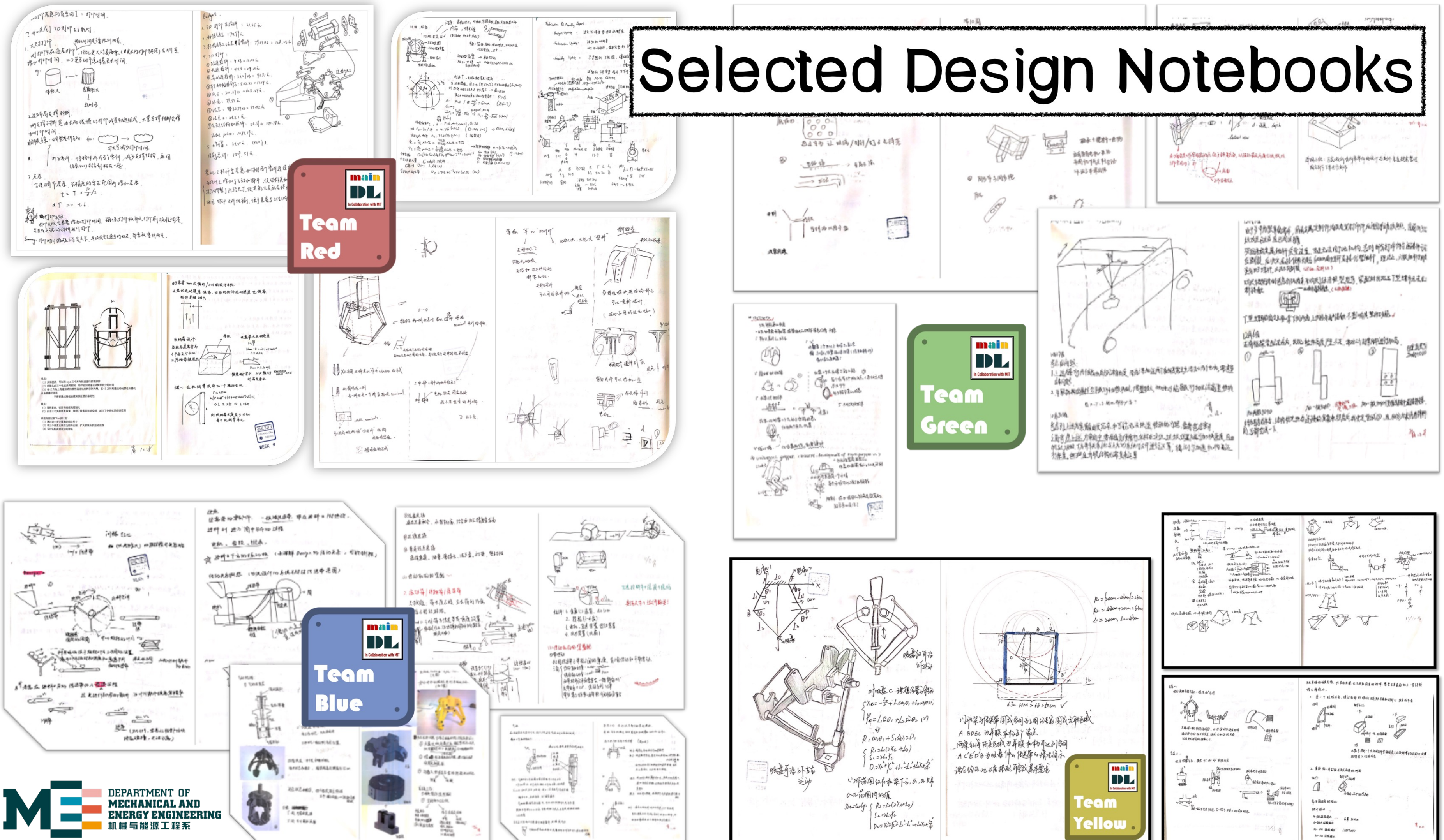
- This selectively compliant manipulator for robotic assembly is primarily cylindrical in design.
- It features two parallel axes that provide compliance in one selected plane.

Delta Robot

Jointed parallelograms connected to a common base

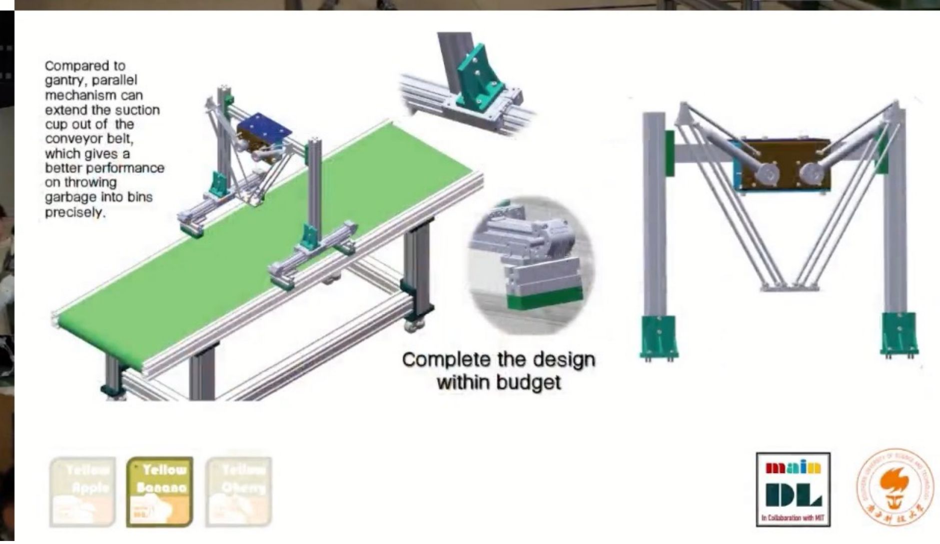
- 3 axes for the parallelograms; 1~3 axes for the end effector
- Delicate, precise movements in a dome-shaped work area
- Heavily used in food, pharmaceutical and electronic industries

Wasteless Design Project

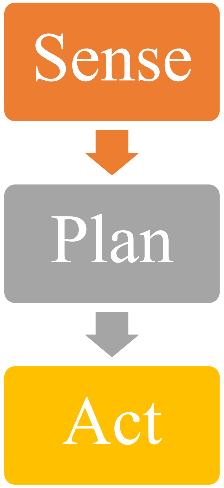


DEPARTMENT OF MECHANICAL AND ENERGY ENGINEERING
机械与能源工程系

Wasteless Design Project



What makes a robot?



- A robot is ***an autonomous machine*** capable of
  - ***sensing*** its environment,
  - carrying out ***computations*** to make decisions, and
  - performing ***actions*** in the real world.

Think of the Roomba robotic vacuum. It uses sensors to autonomously drive around a room, going around furniture and avoiding stairs; it carries out computations to make sure it covers the entire room and when deciding if a spot needs a more thorough cleaning; and it performs an action by "sucking dirt."

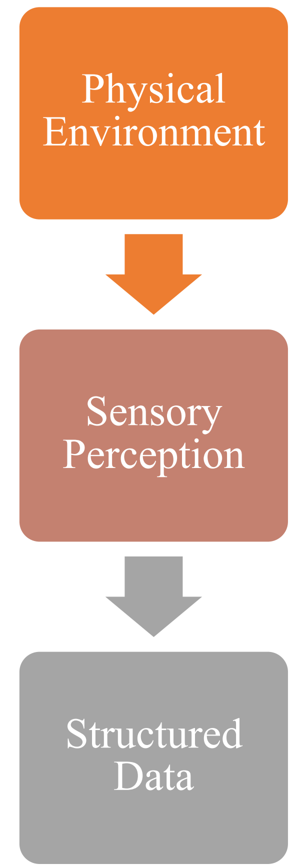
Question: What about an elevator? What about cruise control for cars?

It senses how fast the vehicle is going, compares it to a preset speed, and accelerates or brakes as needed. Is cruise control a robot?

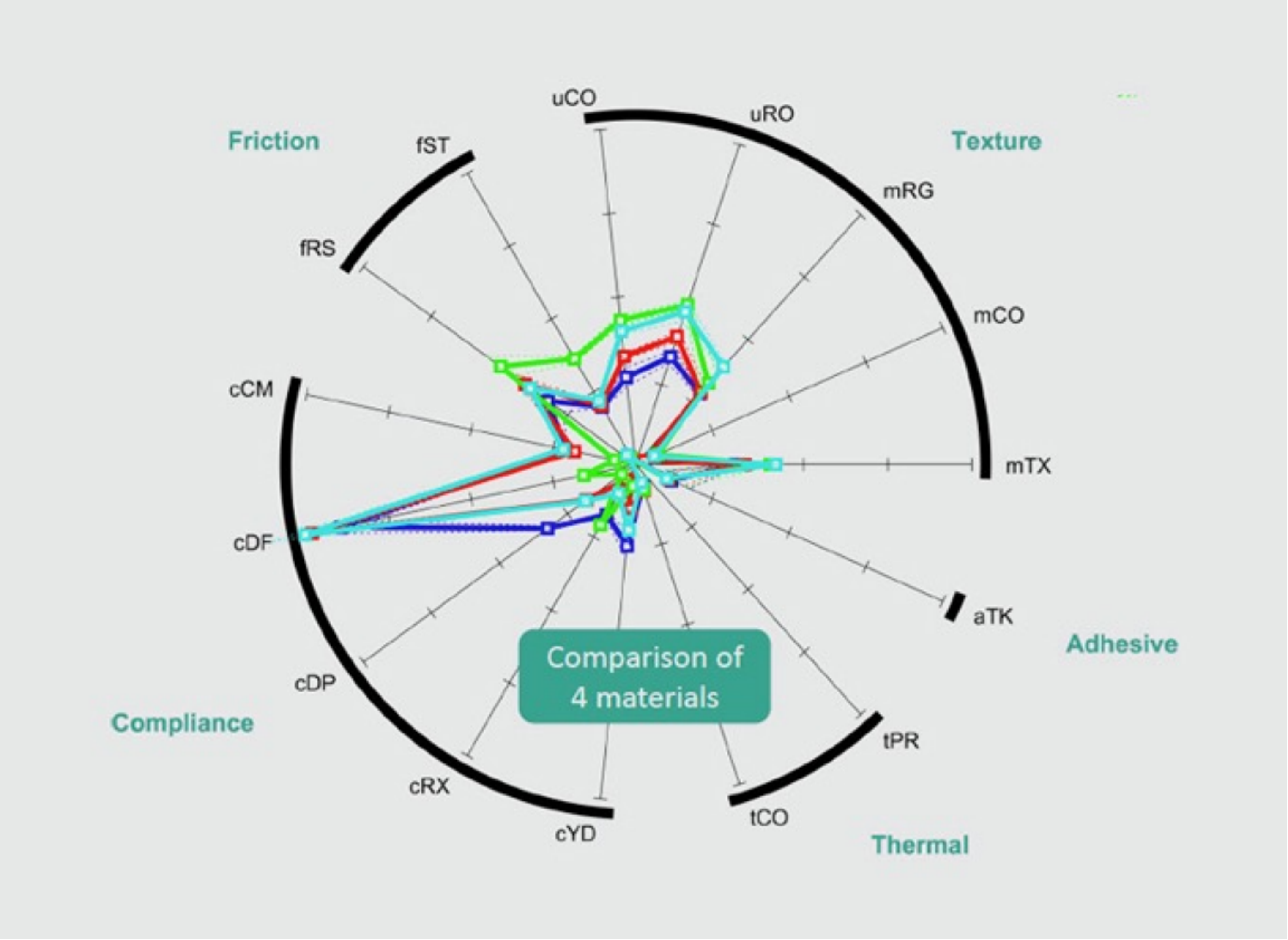
Sensing for Structured Perception

- Perception is the organization, identification, and interpretation of **sensory** **<u>information</u>** in order to represent and understand the interactions or environment.

doi: 10.3389/fnbot.2020.576846



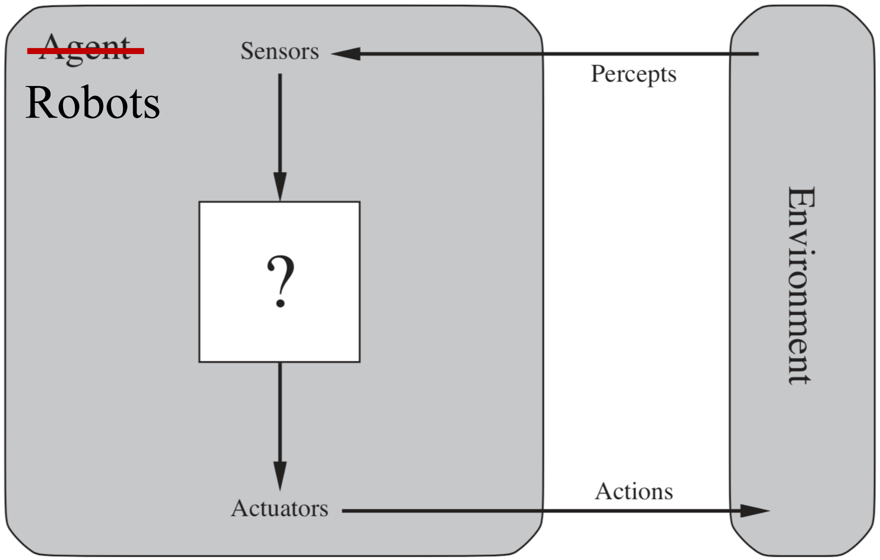
Sensing for Structured Perception



Computing for Algorithmic Rationality

- An algorithm is a **finite sequence** of rigorous instructions, typically used to solve a class of **specific** problems or to perform a **computation**.

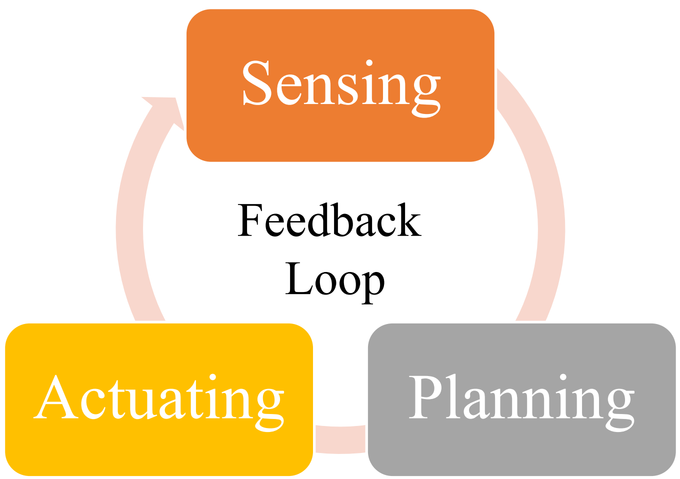
- An agent (or robot) is an entity that perceives and acts.
  - Intelligence is concerned mainly with rational action
- Ideally, an intelligent agent takes the best possible action in a situation.
  - A rational agent selects actions that maximize its (expected) utility.
- Characteristics of the percepts, environment, and action space dictate techniques for selecting rational actions.



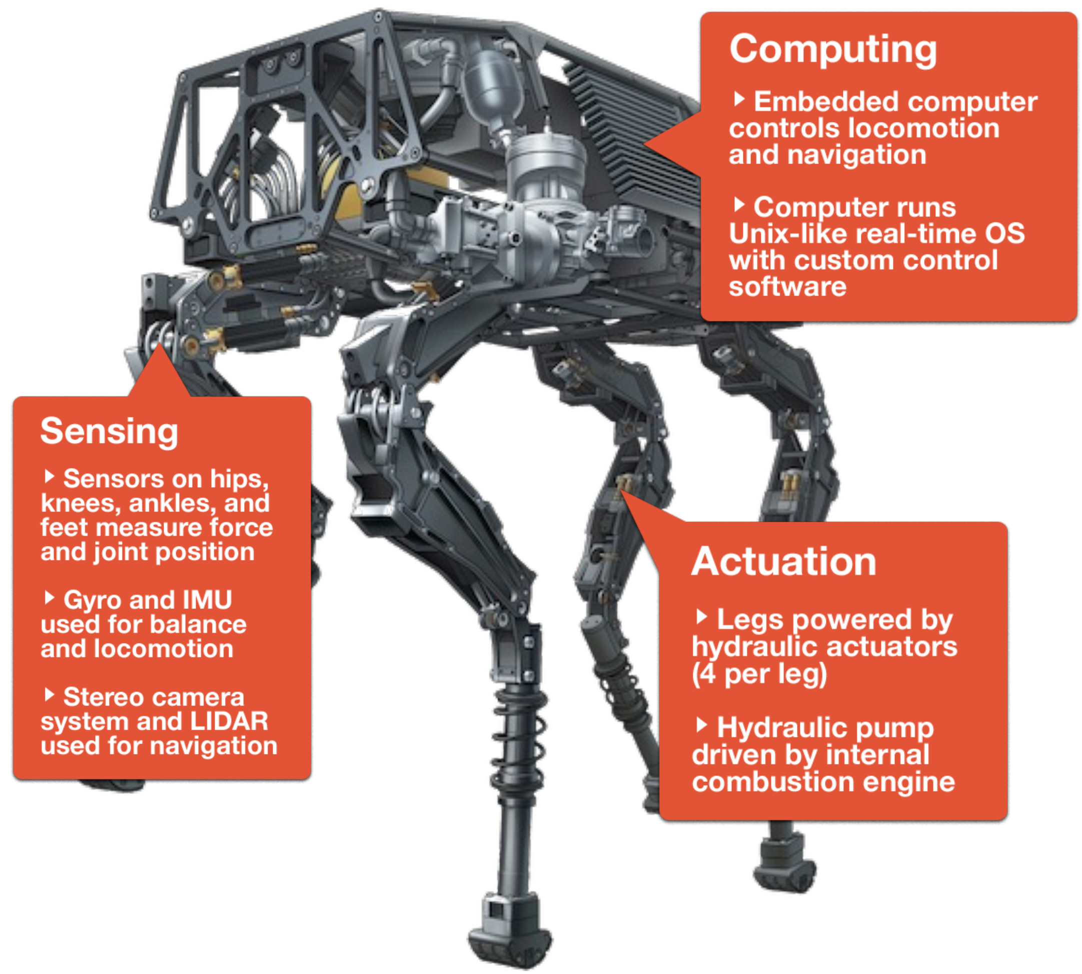
Actuating for Physical Interactions

https://www.youtube.com/watch?v=I2_-etus0KQ

Feedback Loop Towards Autonomy



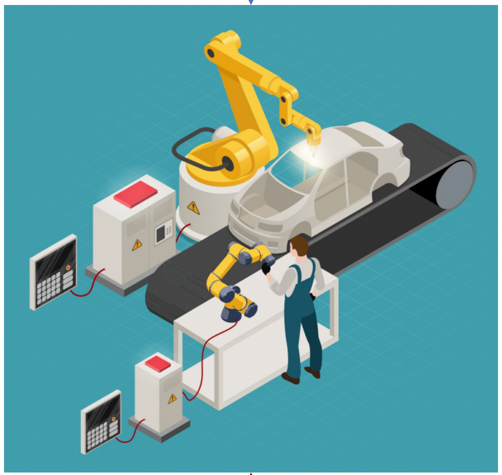
The sensors feed measurements to a controller or computer, which processes them and then sends control signals to motors and actuators.



BigDog, a rough-terrain quadruped robot developed by U.S. firm Boston Dynamics.

Factory Robot vs. Collaborative Robot

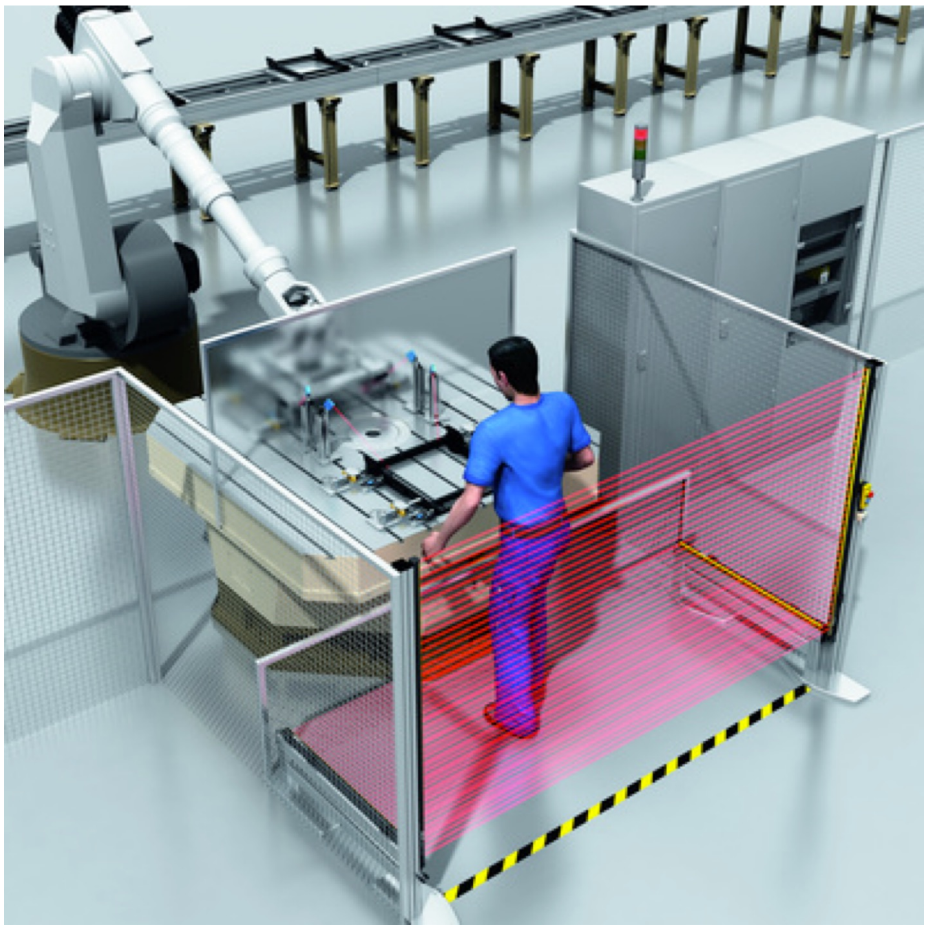
- Factory robots perform automated programmable movements in manufacturing.
- Mechanical or sensor technologies can help keep factory robots from interfering with human activity.



- Cobots work side by side with humans to improve work quality.
- A cobot can sense and stop movement, helping create a safer working environment.

Towards a Safer Working Environment

Mechanical or sensor technologies can help keep robots from interfering with human activity



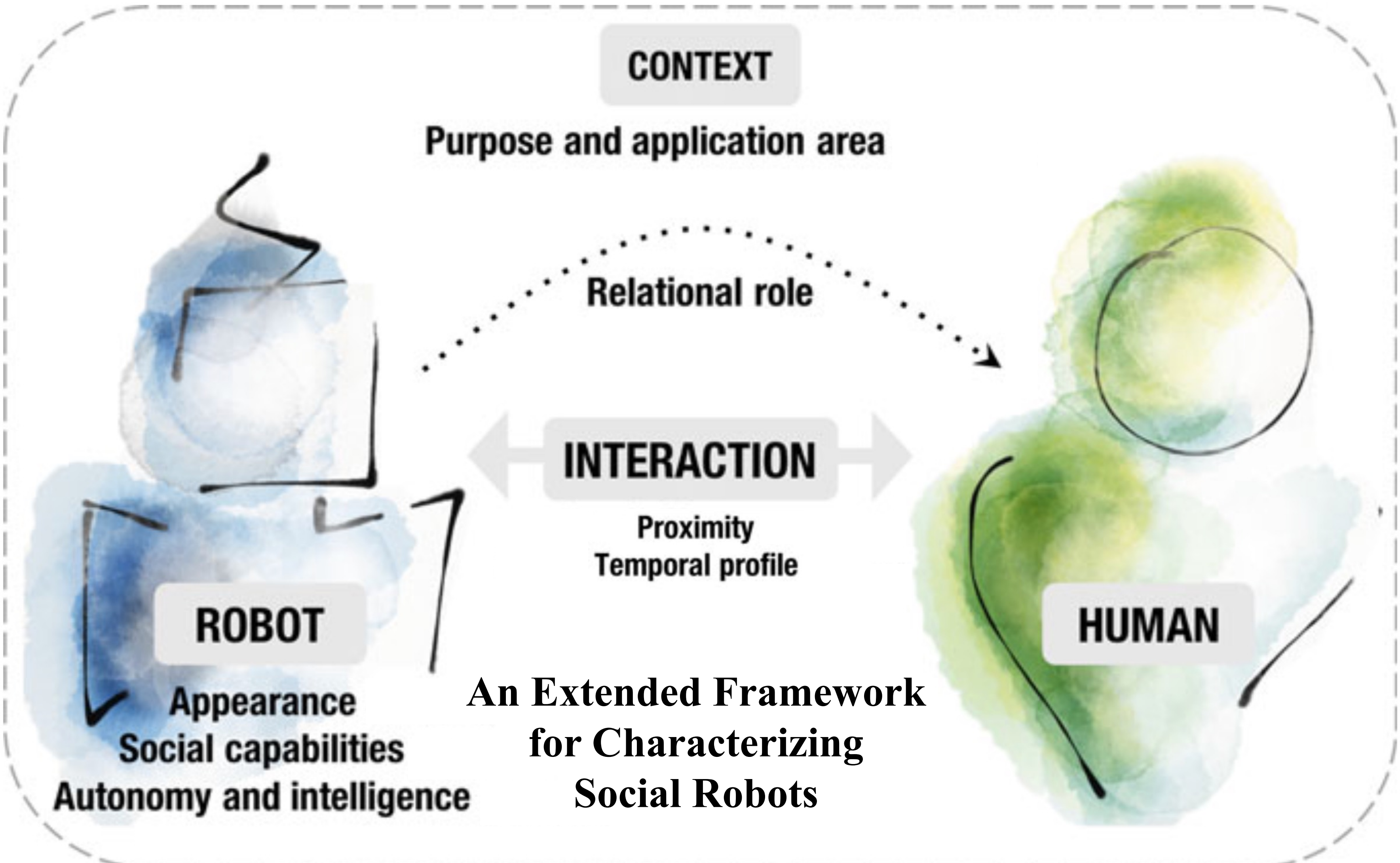
Why Design the Robots?

- Robots are machines that sense, plan, and act towards autonomous interactions for the sake of human.

- Robots are machines
  - Designed by the humans
  - To serve a specific purpose
  - On behalf of human operators

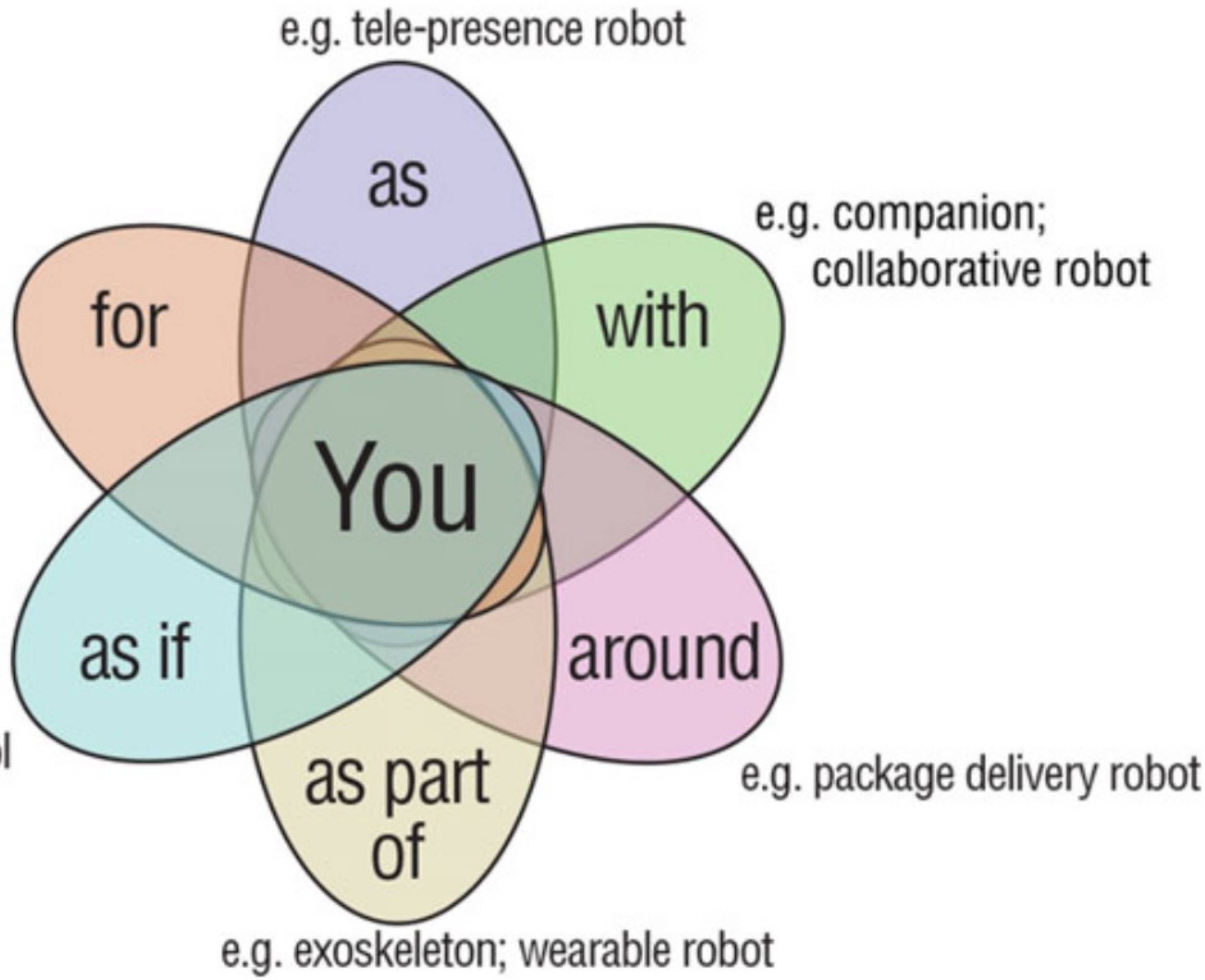
- Human is essential to the fundamental existance of a robot

Social Characteristics of Robots



10.1007/978-3-030-42307-0_2

Revisit the Reason Why You Like Robots



10.1007/978-3-030-42307-0_2

DES5002 Team Formation

https://ancorasir.com/?page_id=3262

Deadline for submission:
Sunday Sep 11 @ 23:30

DES5002 Assignment

Survey on Robots for Social Good

https://ancorasir.com/?page_id=3273

Deadline for submission:
Friday Oct 07 @ 23:30

Thank you~

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