

## Lecture 2

# “I am social robot.”

### Dimensions of social robot design

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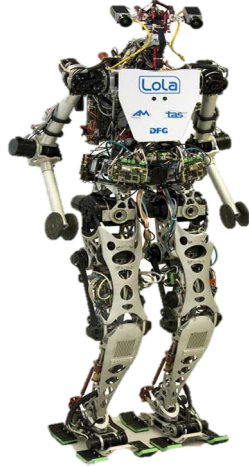
# Learning objectives

By the end of this lecture, you should be able to:

- 1 – Identify relevant dimensions that characterize social robots
- 2 – Critically discuss how these dimensions affect the human-robot interaction
- 3 – Identify technical challenges associated with choices on some of these dimensions
- 4 – Apply these dimensions to the brainstorming phase of a social robot design process

What comes to mind when you hear “social robot”?

# “Social” robots?



Is this a social robot?



Is this a social robot?



Is this a social robot?





<https://emalliaraki.com/social-drones>



# Defining “social robots”

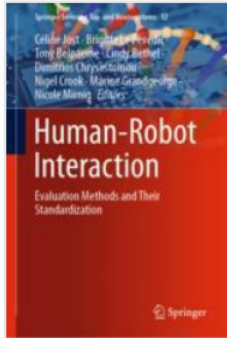
No strict (binary) definition → Think about **levels** of “socialness”

**Appearance** and **behavior** both play a role and should go hand in hand



In this lecture: “broad” understanding of social robots as being socially interactive

# Design space for socially interactive robots



[Human-Robot Interaction](#) pp 21-64 | [Cite as](#)

## An Extended Framework for Characterizing Social Robots

Authors

[Authors and affiliations](#)

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Kim Baraka , Patrícia Alves-Oliveira , Tiago Ribeiro

What are some important factors (dimensions) to think about when designing robots that interact with people?

CONTEXT

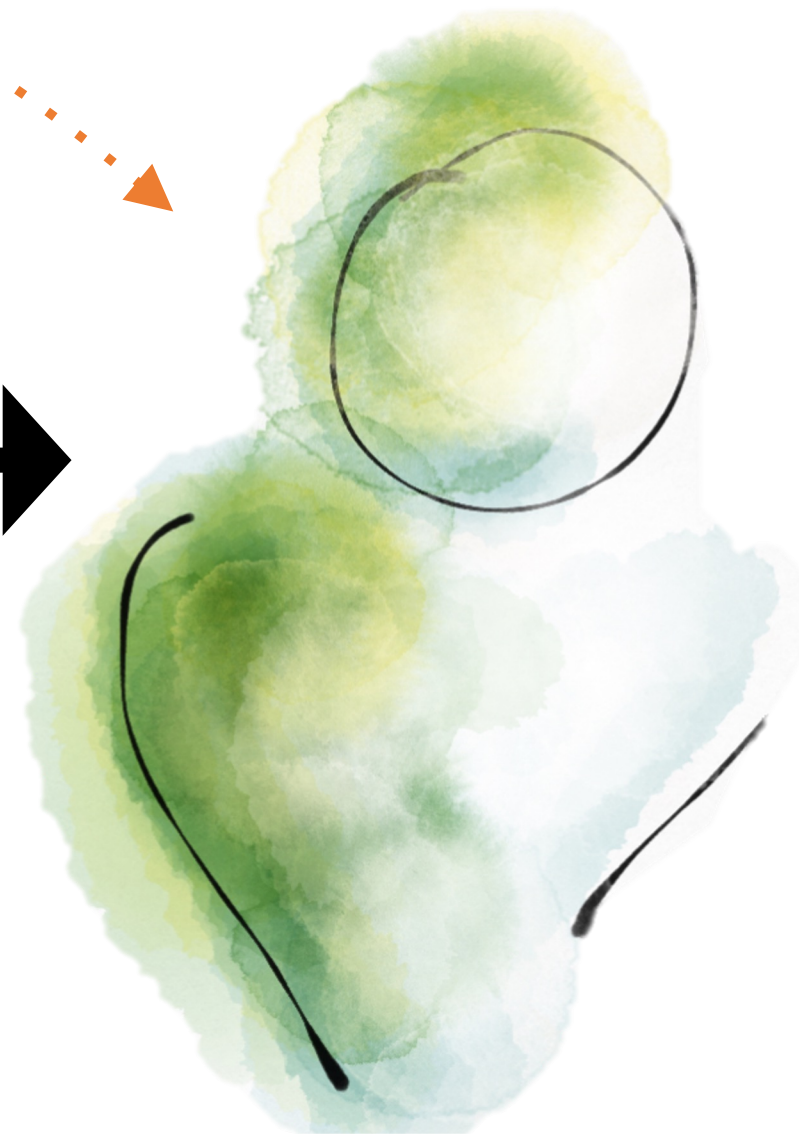
Purpose and application area

Relational role

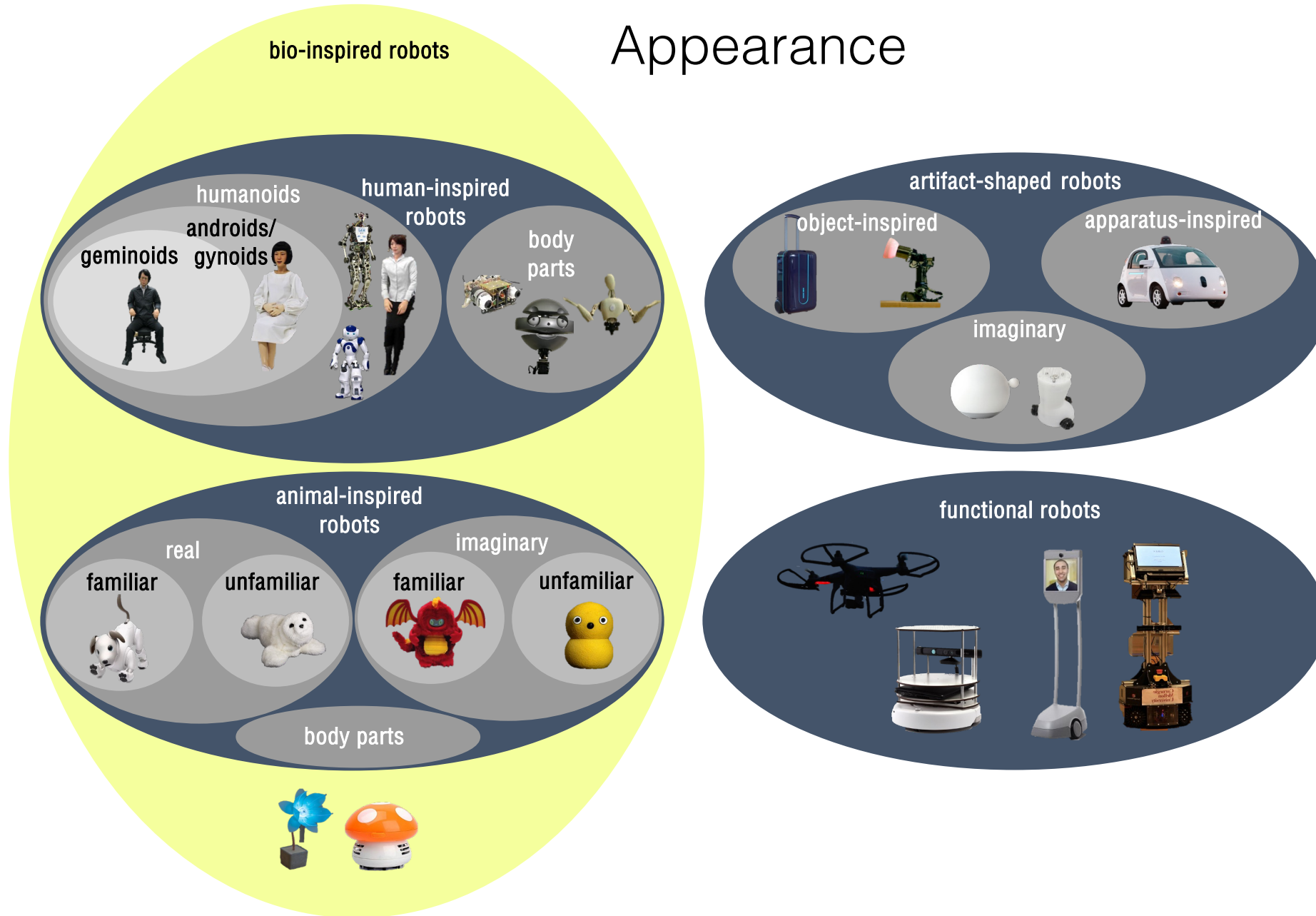
INTERACTION

Proximity  
Temporal profile

Appearance  
Social capabilities  
Autonomy and intelligence



# Appearance



# Appearance

bio-inspired robots

humanoids  
androids/  
geminoids  
gynoids



human-inspired  
robots

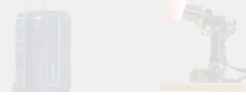


body  
parts



artifact-shaped robots

object-inspired



apparatus-inspired



Research challenges:

- Appearance sets expectations → trust
- Uncanny valley should be avoided
- Anthropomorphic embodiments are not always desirable

anim

real

familiar



unfamiliar



body parts



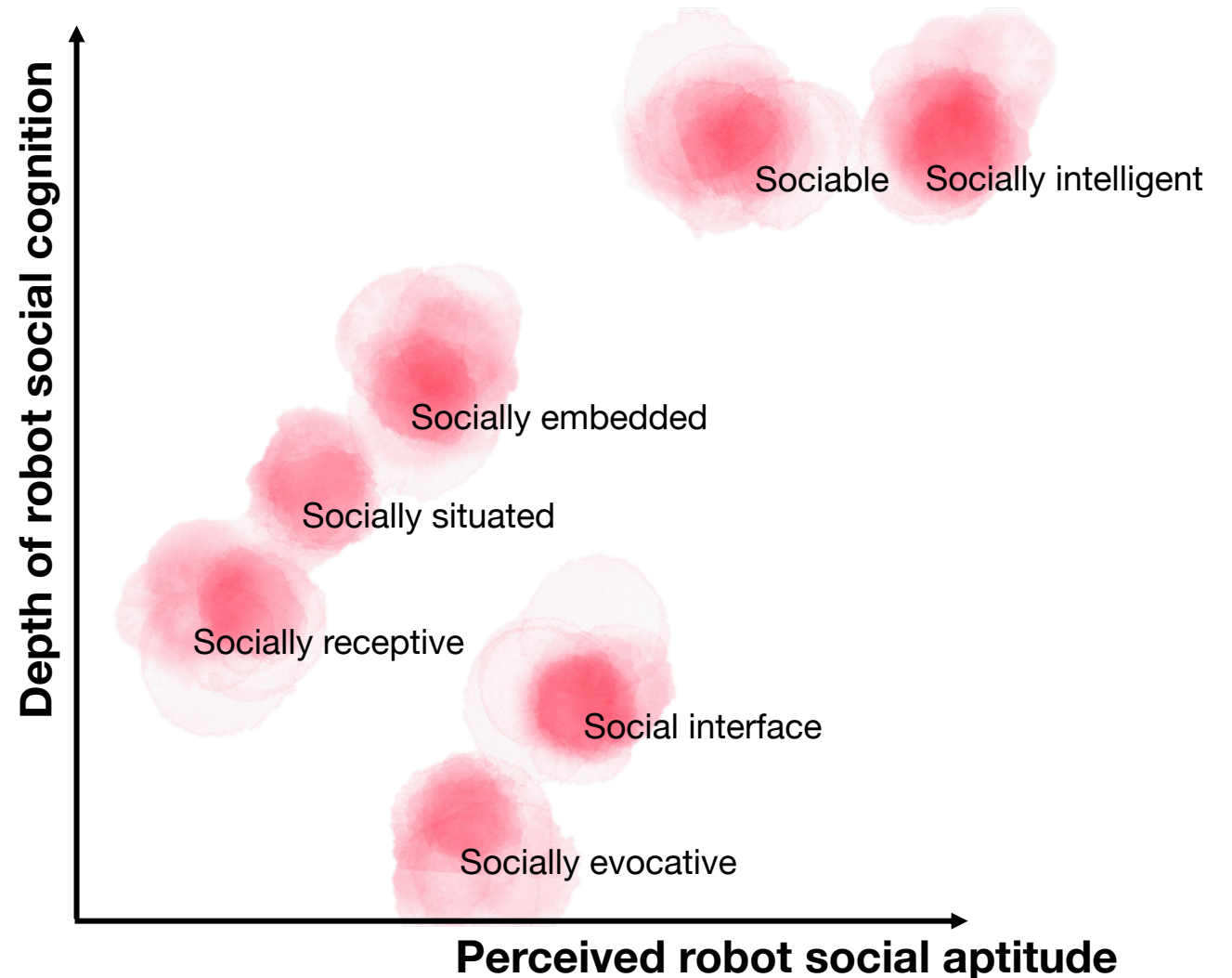
# Social capabilities

Components of social interactivity for robots (adapted from Fong et al. 2002):

- Communicating using natural language or non-verbal modalities
- Expressing affect and/or perceiving human emotions
- Exhibiting distinctive personality and character traits
- Modeling and recognizing social aspects of humans
- Learning and developing new social skills and competencies
- Establishing and maintaining social relationships

# Social capabilities

- **Socially evocative:** evoke social and emotional responses in humans
- **Social interface:** use human-like social cues and communication
- **Socially receptive:** socially passive but benefit from interaction
- **Socially situated:** surrounded by a social environment they can interact with
- **Socially embedded:** structurally coupled with social environment and aware of interactional structures
- **Sociable:** pro-actively engage with humans to satisfy internal social aims
- **Socially intelligent:** human-style social intelligence with deep models of cognition and social competence



# Social capabilities

- **Socially evocative:** evoke social and emotional responses in humans
- **Social interface:** use human-like social cues and communication
- **Socially receptive:** socially passive but benefit from interaction

al cognition ↑

Sociable    Socially intelligent

**Research challenge:**

**Designing social intelligence has many facets and requires knowledge from several disciplines**

- **Socially situated:** socially aware of the environment they are in
- **Socially embedded:** socially coupled with social environment and aware of interactional structures
- **Sociable:** pro-actively engage with humans to satisfy internal social aims
- **Socially intelligent:** human-style social intelligence with deep models of cognition and social competence

Depth ↓

Socially receptive

Social interface

Socially evocative

**Perceived robot social aptitude** →



# Micro-assignment

Components of social interactivity for robots (adapted from Fong et al. 2002):

- Communicating using natural language or non-verbal modalities
- Expressing affect and/or perceiving human emotions
- Exhibiting distinctive personality and character traits
- **Modeling and recognizing social aspects of humans**
- Learning and developing new social skills and competencies
- Establishing and maintaining social relationships

Pick one specific problem related to “modeling and recognizing social aspects of humans” and sketch what an AI solution to this problem could look like (5 sentences).

# Purpose and application area

## Healthcare and therapy



NAO and child with ASD interacting



Paro emotionally assisting the elderly



Baxter assisting a blind person



Robota assisting a child with ASD



Pearl assisting an elder person



SeRoDi assisting an elder person

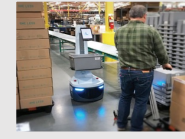


Rebear carrying a patient

## Industry

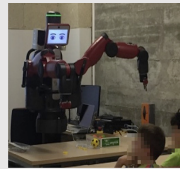


Baxter being synesthetically taught in a factory



Locusbots™ collaboratively operating in a warehouse

## Education, entertainment and art



Baxter teaching children



Furby with a child



HERB acting in a play



Bee-bot used for educational activities

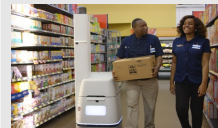
## Home and workplace



CoBot navigating an office corridor



Care-O-bot 4 in a home



Bossa Nova's supermarket robot

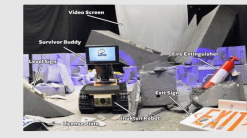


HERB engaging in kitchen tasks

## Search and rescue



Inuktun and Packbot equipped with social behavior

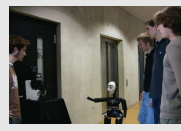


Survivor buddy / Inuktun in a simulated disaster environment

## Public service



Roboceptionist at department reception



Robotinho on a museum tour

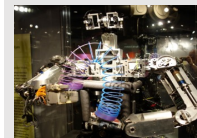


Robovie in a shopping mall

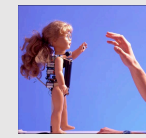


Pepper at a store entrance

## Social sciences



Cog used to study human cognition



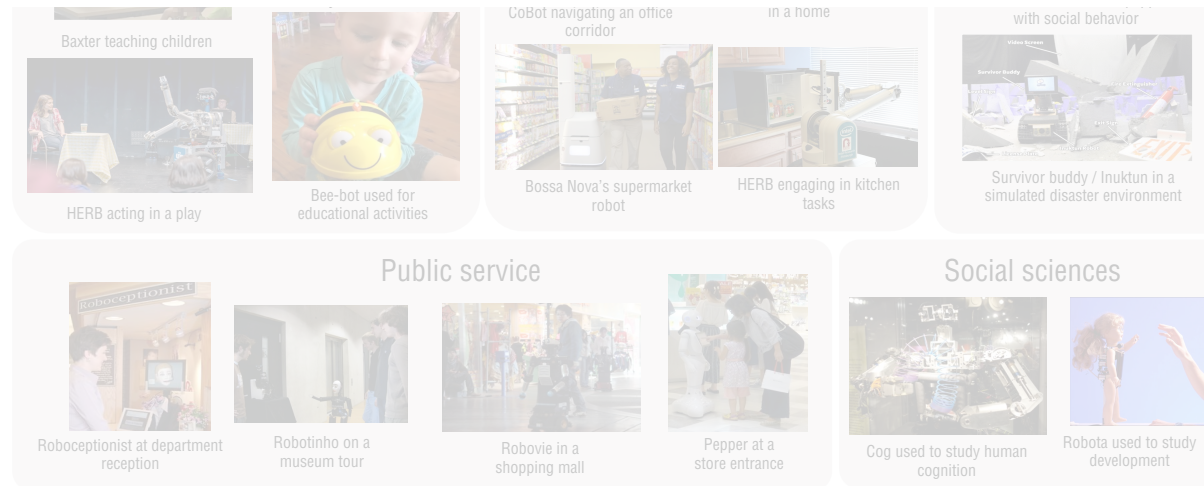
Robota used to study development

# Purpose and application area

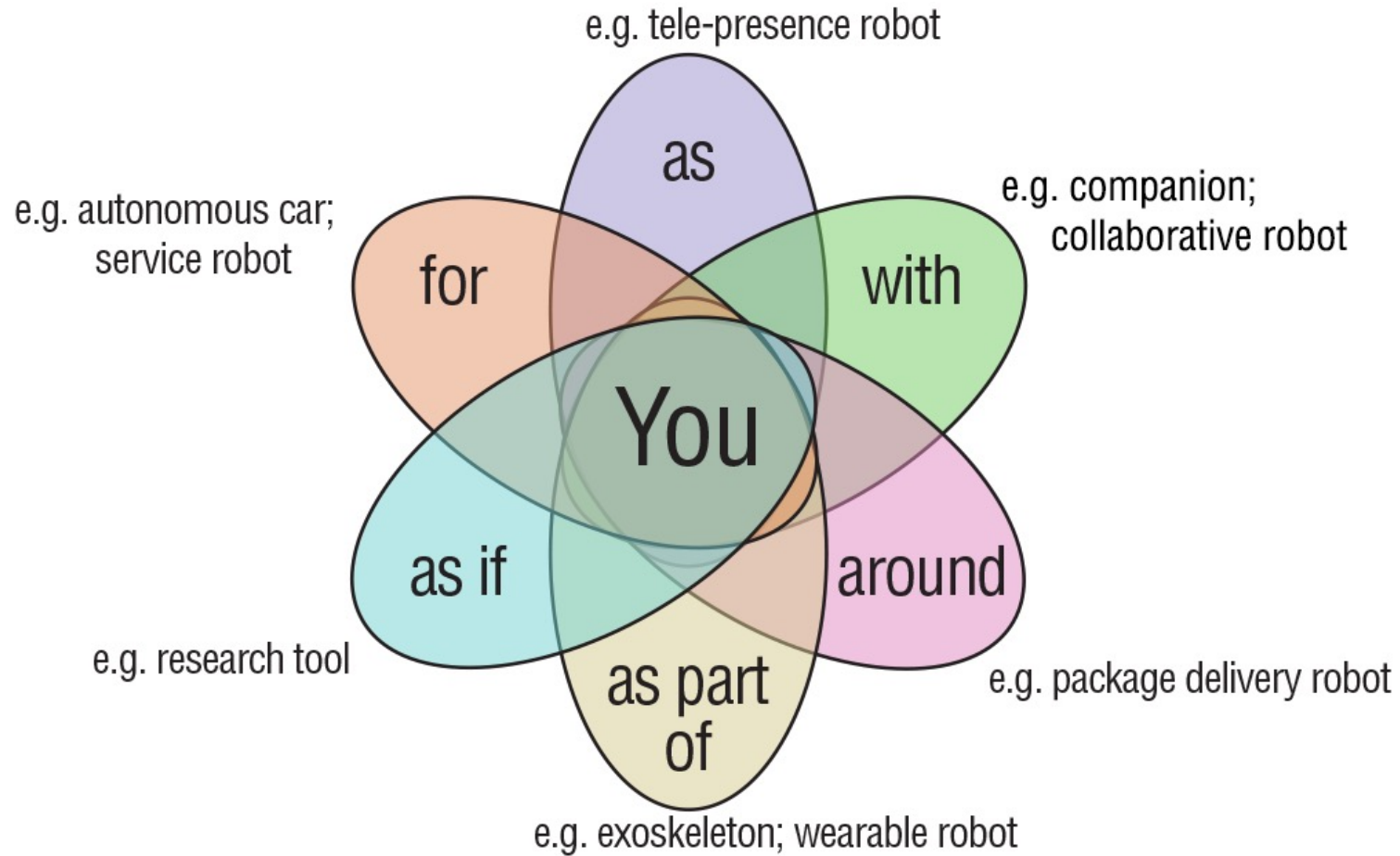


## Research challenges:

- User-centered design based on intended application
- Expand to new applications areas



# Relational role



# Relational role









## Research challenges:

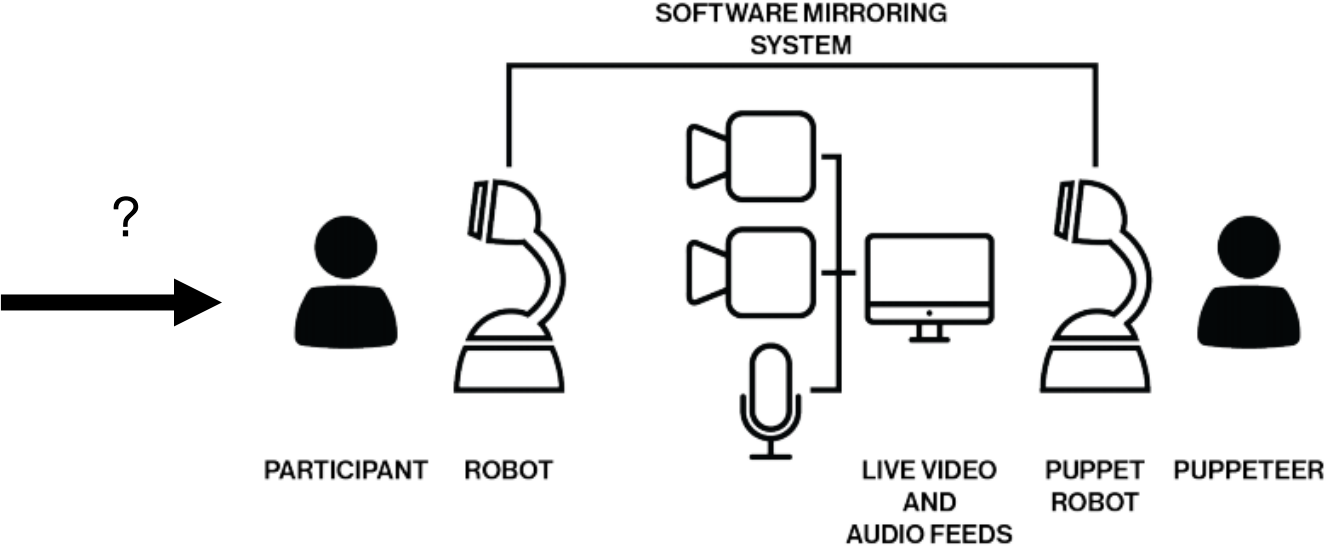
- Consider how the role of the robot affects the interaction dynamics
- Expand to new roles



# Autonomy and intelligence

6 LEVELS OF AUTONOMOUS DRIVING					
					
<b>L0</b>	<b>L1</b>	<b>L2</b>	<b>L3</b>	<b>L4</b>	<b>L5</b>
<b>NO AUTOMATION</b>	<b>DRIVER ASSISTANCE</b>	<b>PARTIAL AUTOMATION</b>	<b>CONDITIONAL AUTOMATION</b>	<b>HIGH AUTOMATION</b>	<b>FULL AUTOMATION</b>
Manual control. The human performs all driving task (steering, Acceleration, braking, etc)	The vehicle features a single automated system (e.g. it monitors speed through cruise control).	ADAS. The vehicle can perform steering and acceleration. The human still monitors all tasks and can take control at any time.	Environmental detection capabilities. The vehicle can perform most driving tasks, but human override is still required.	The vehicle performs all driving tasks under specific circumstances. Geofencing is required. Human override is still an option.	The vehicle performs all driving tasks under all conditions. Zero human attention or interaction is required.

Source: medium.com (user Pratyush Atri)

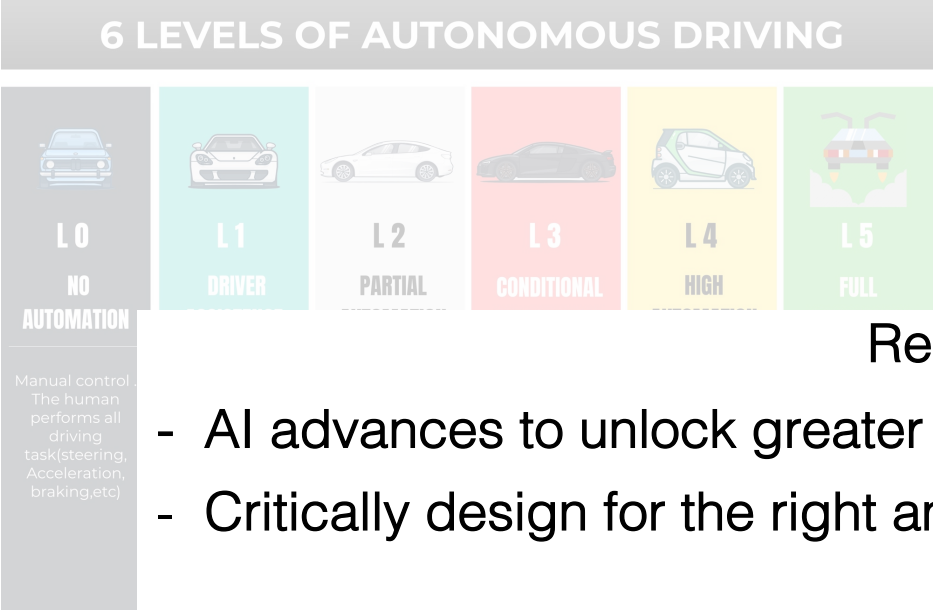


Tennent et al., HRI 2018

**Autonomy** — “The extent to which a robot can operate in the tasks it was designed for (or that it creates for itself) without external intervention.”

**Intelligence** — “The ability to determine behavior that will maximize the likelihood of goal satisfaction under dynamic and uncertain conditions, linked to the environment and the interaction with other (possibly human) agents.

# Autonomy and intelligence



## Research challenges:

- AI advances to unlock greater possibilities of autonomy
- Critically design for the right amount of autonomy according to the application

Source: medium.com (user Pratyush Atri)

Tennent et al. HRI 2018

**Autonomy**—“The extent to which a robot can operate in the tasks it was designed for (or that it creates for itself) without external intervention.”

**Intelligence**—“The ability to determine behavior that will maximize the likelihood of goal satisfaction under dynamic and uncertain conditions, linked to the environment and the interaction with other (possibly human) agents.



# Proximity

Remote



Photo credit: iRobot

- Latency
- Social presence
- Shared autonomy
- Non-verbal communication (e.g., gaze and proxemics)
- ...

Co-located



- Situated communication
- Social navigation
- Perception of social cues
- ...

Physical



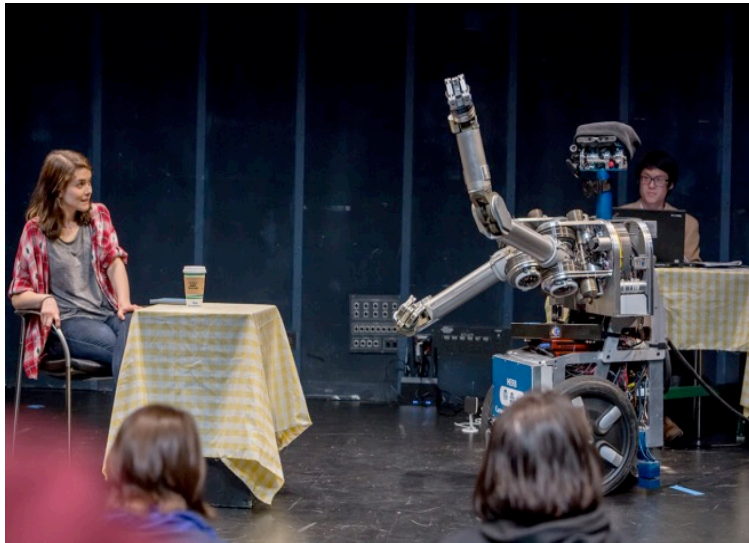
- Haptic control
- Social meaning of touch
- Safety



# Temporal profile

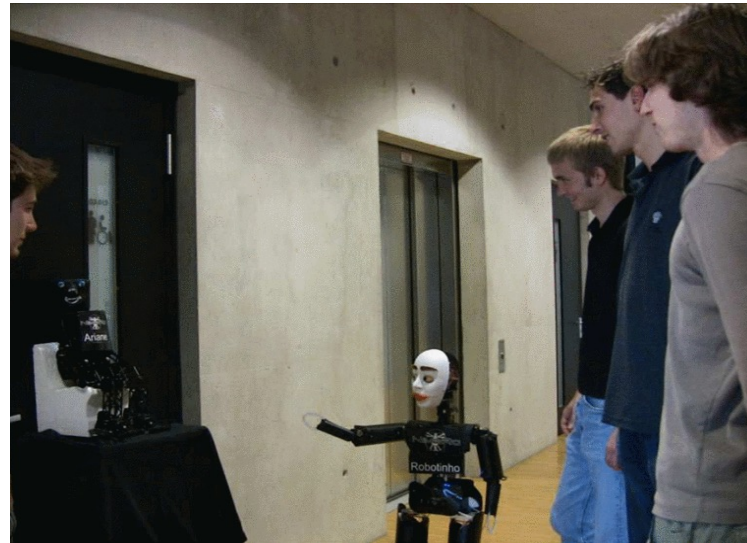
Timespan

Short-term



Zeglin et al., 2014

Medium-term



Faber et al., 2009

Long-term



Baraka et al., 2016

Also consider **duration** and **frequency** of interactions

# Temporal profile

Short-term

Medium-term

Long-term



Timespan

## Research challenges:

- Novelty, surprise and sustained engagement
- Intuitive versus “coded” robot-to-human communication
- Human-robot relationship and trust

Also consider **duration** and **frequency** of interactions

CONTEXT

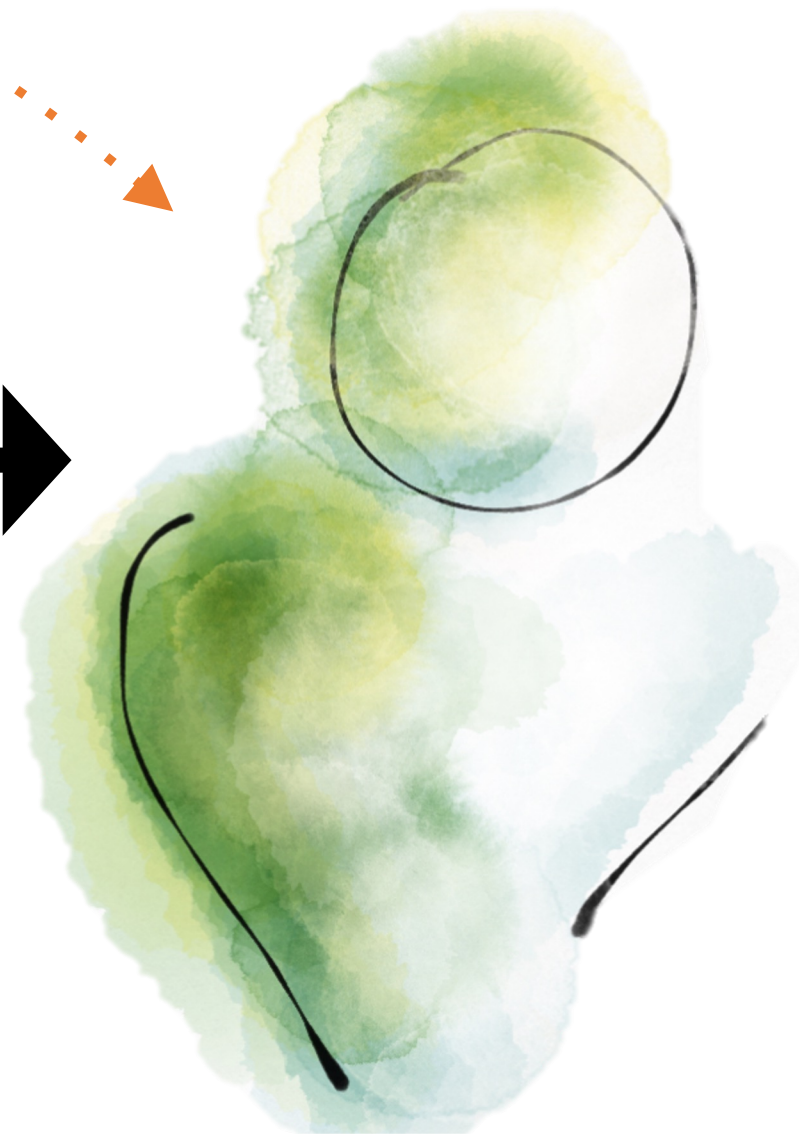
Purpose and application area

Relational role

INTERACTION

Proximity  
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Appearance  
Social capabilities  
Autonomy and intelligence



What other dimensions would you add to this framework?