CLOUD-CONNECTED SOCIAL ROBOTS FOR HEALTHY AGING

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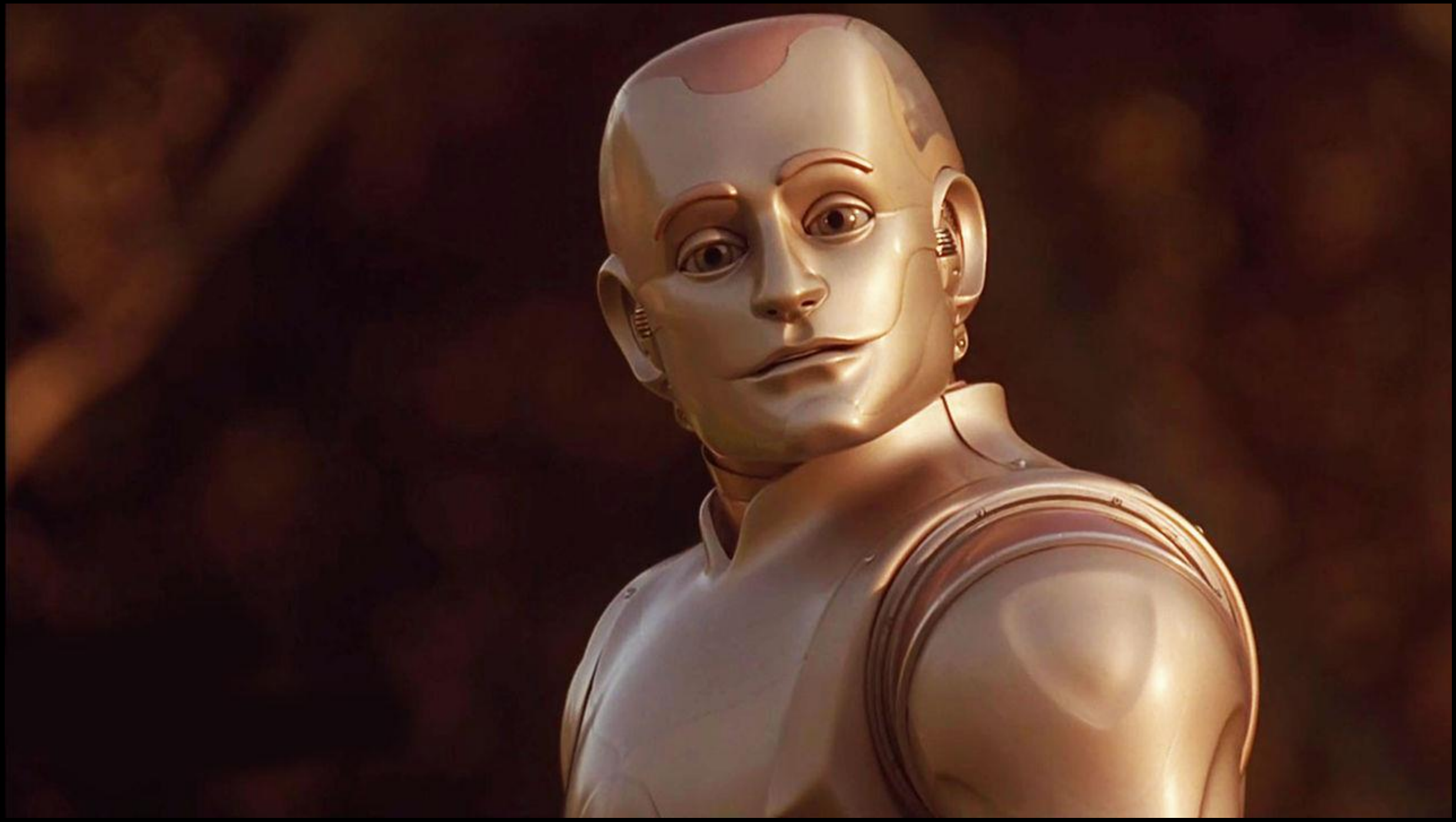
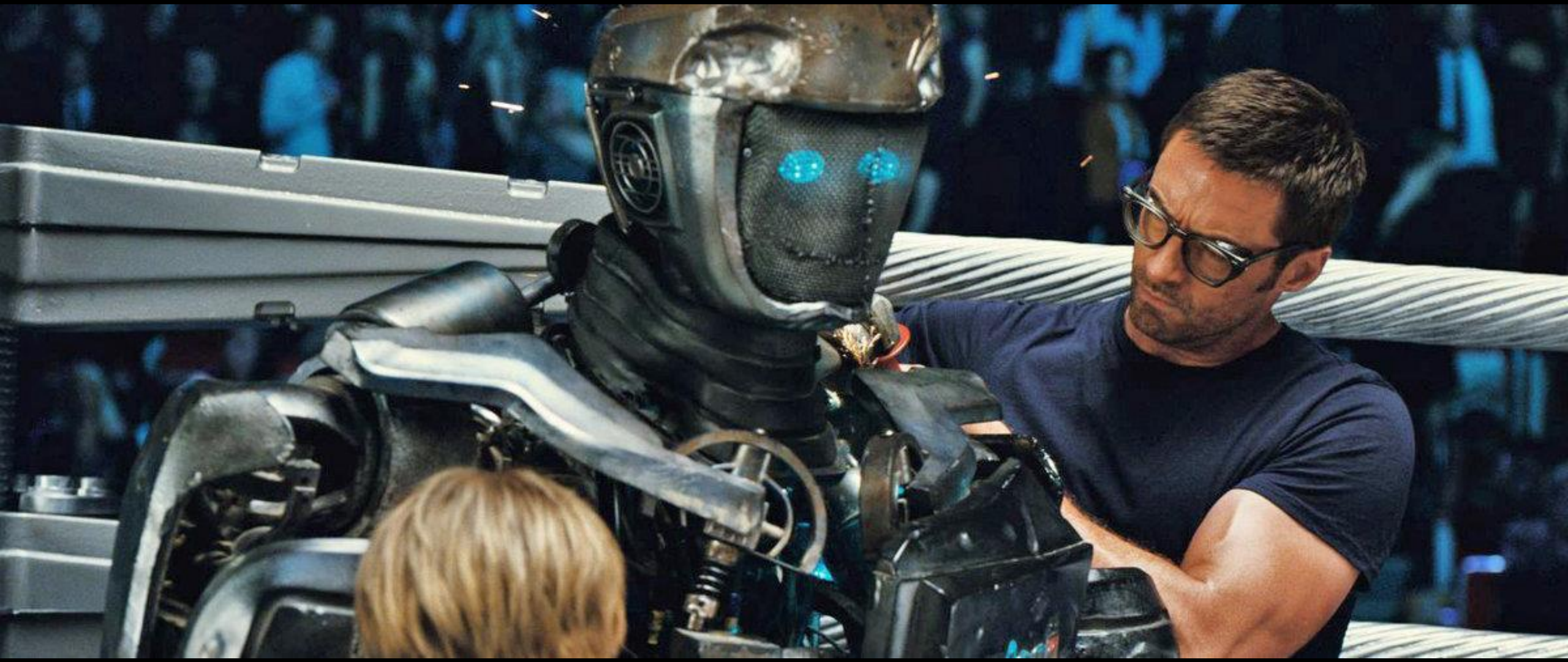
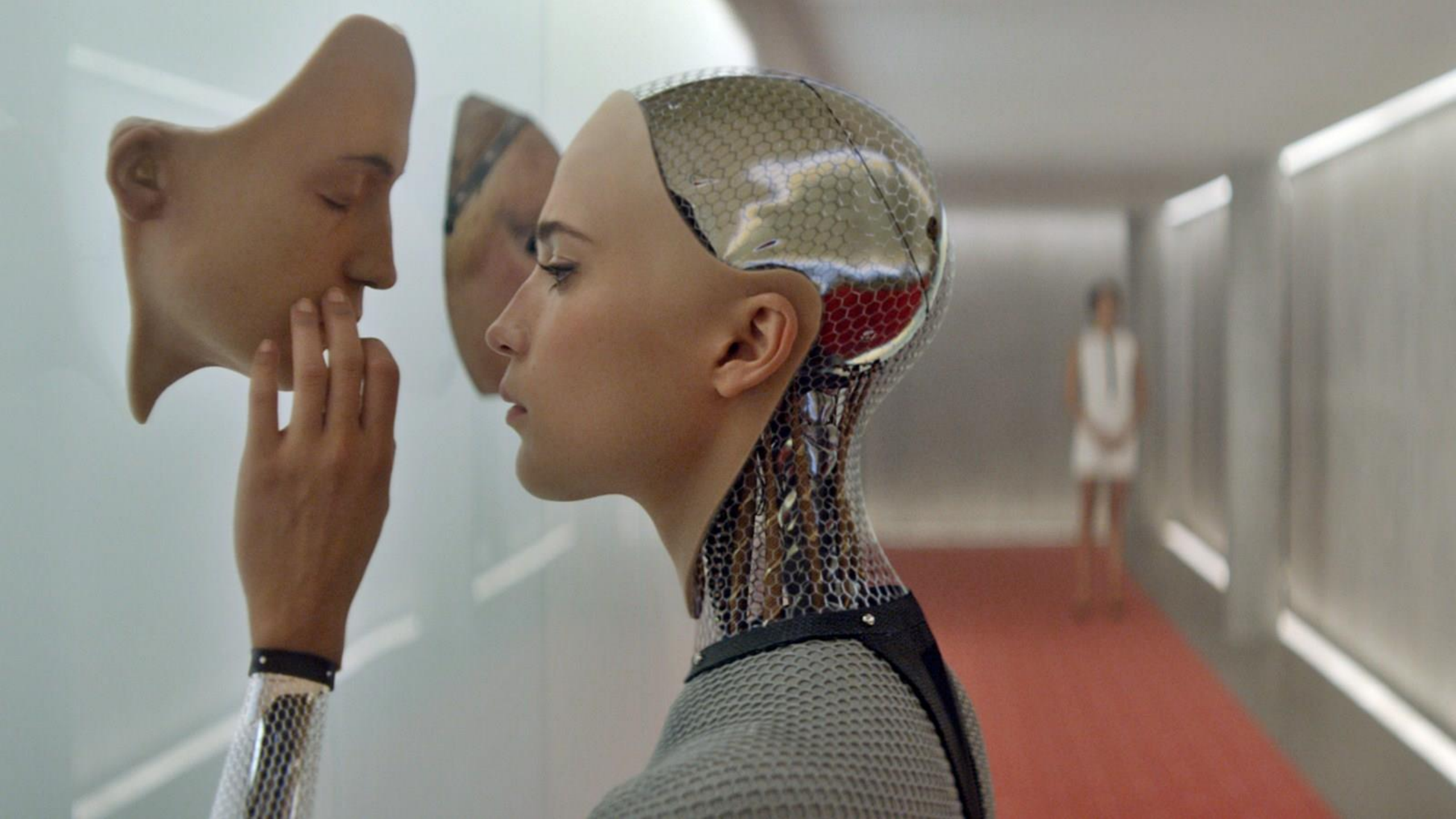
What does the word robot mean?

Where was it born?

How we imagine (assistive/social) robots?

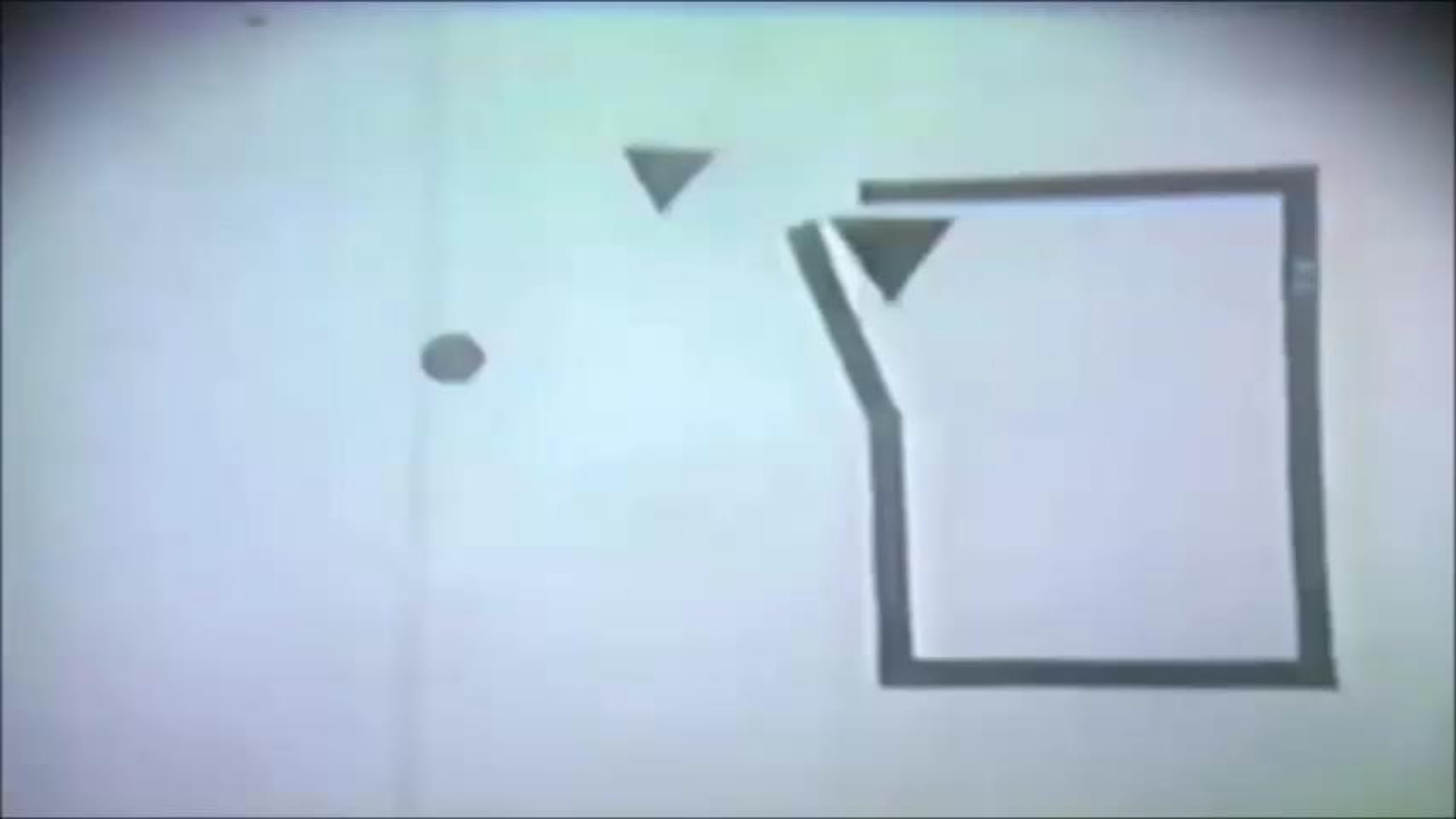


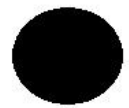




We humans are the ‘ultimate’ social species

Social brain



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333-2
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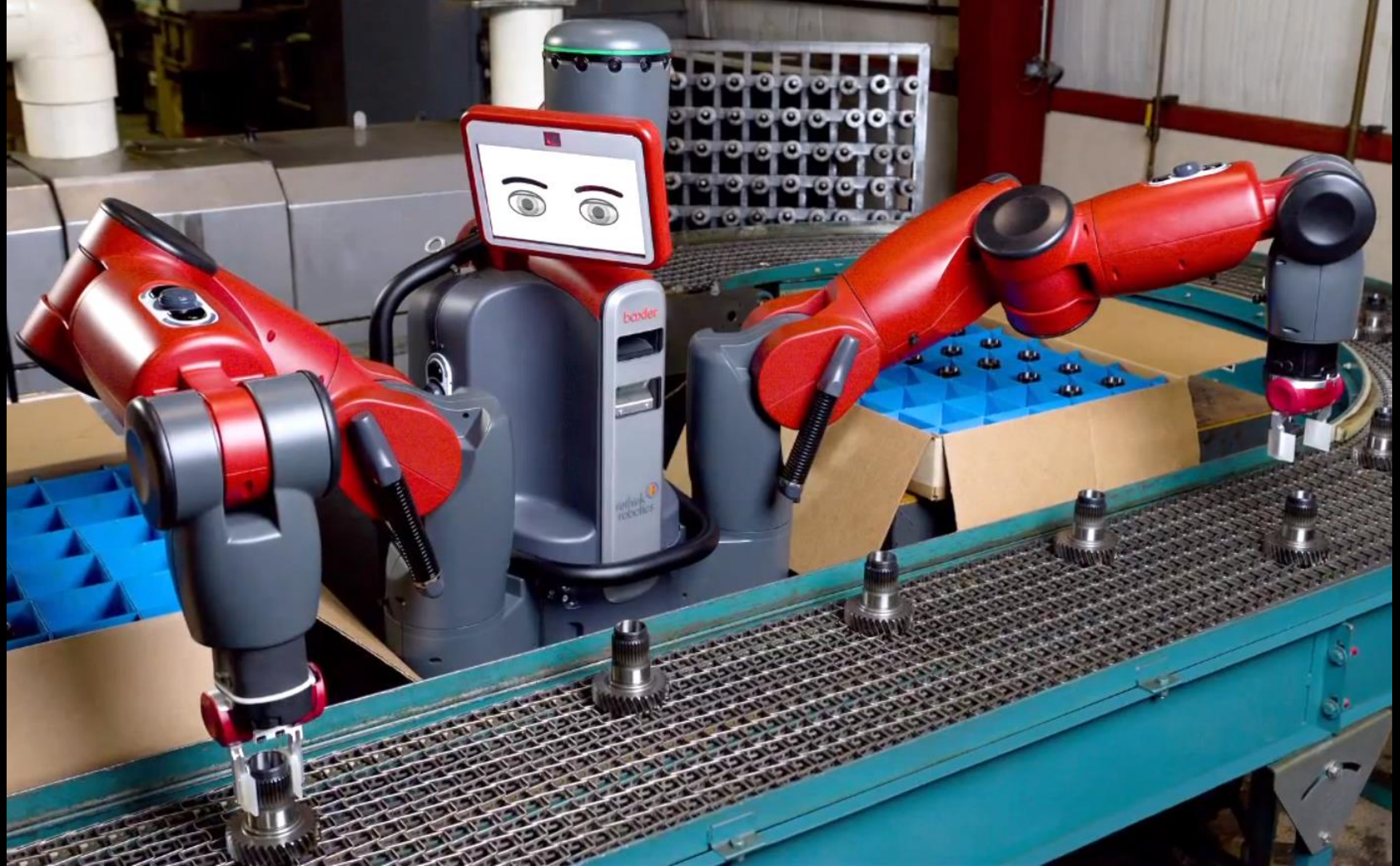
@YoUnGeStEr...

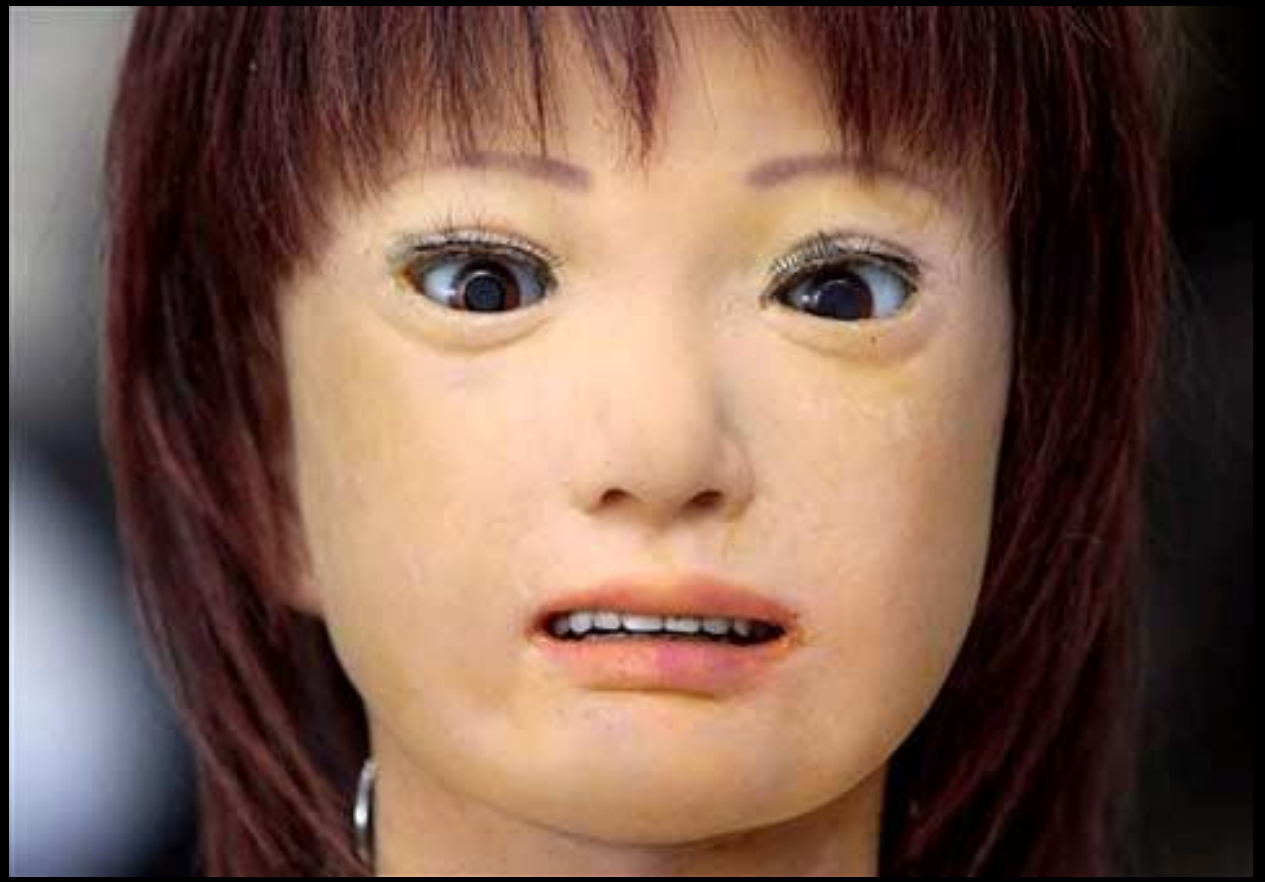

HERO3
05:05

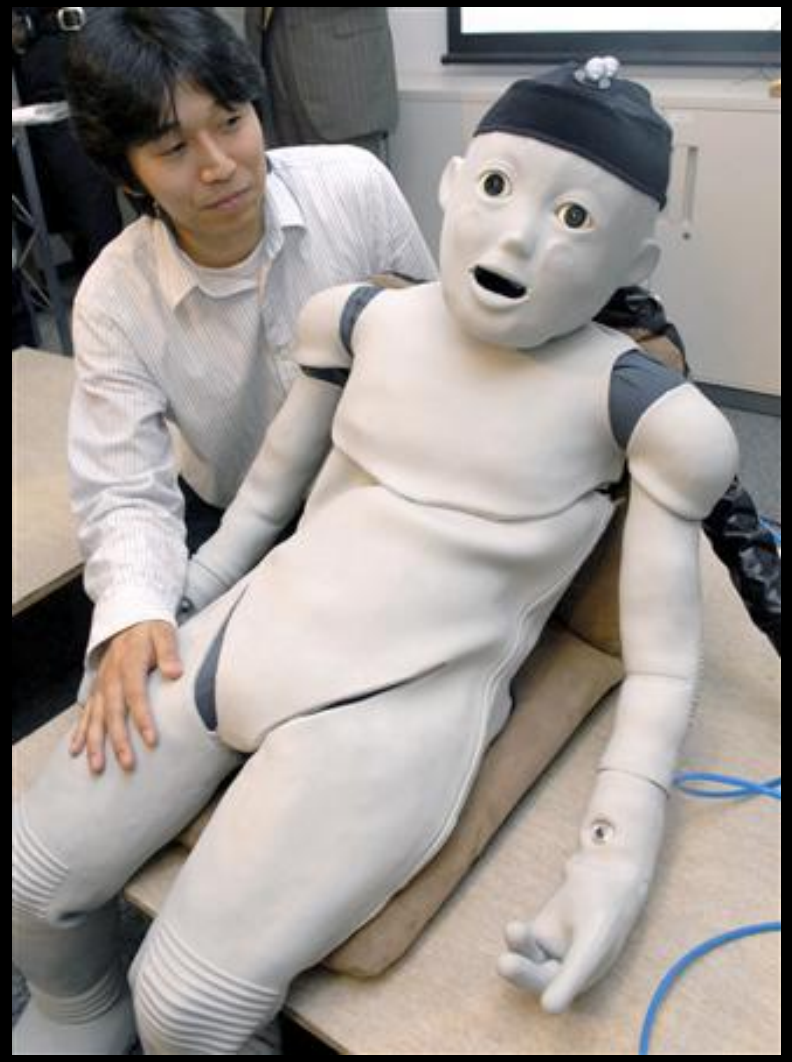

1512


YASKAWA

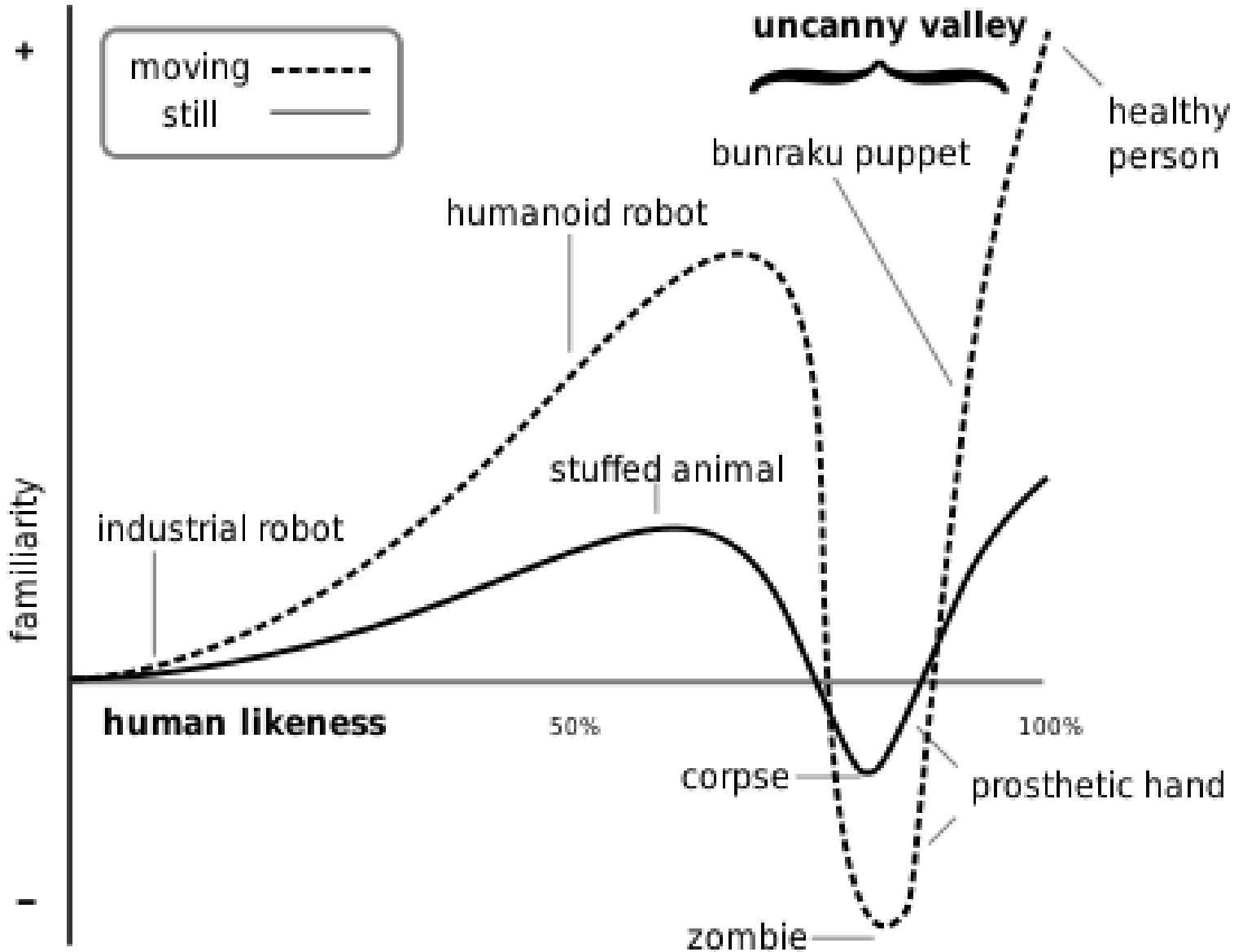

baxter
rethink robotics

What kind of robots people like?






JustStrange


+
familiarity
-
moving
still
uncanny valley
healthy person
bunraku puppet
humanoid robot
stuffed animal
industrial robot
human likeness
50%
100%
corpse
prosthetic hand
zombie

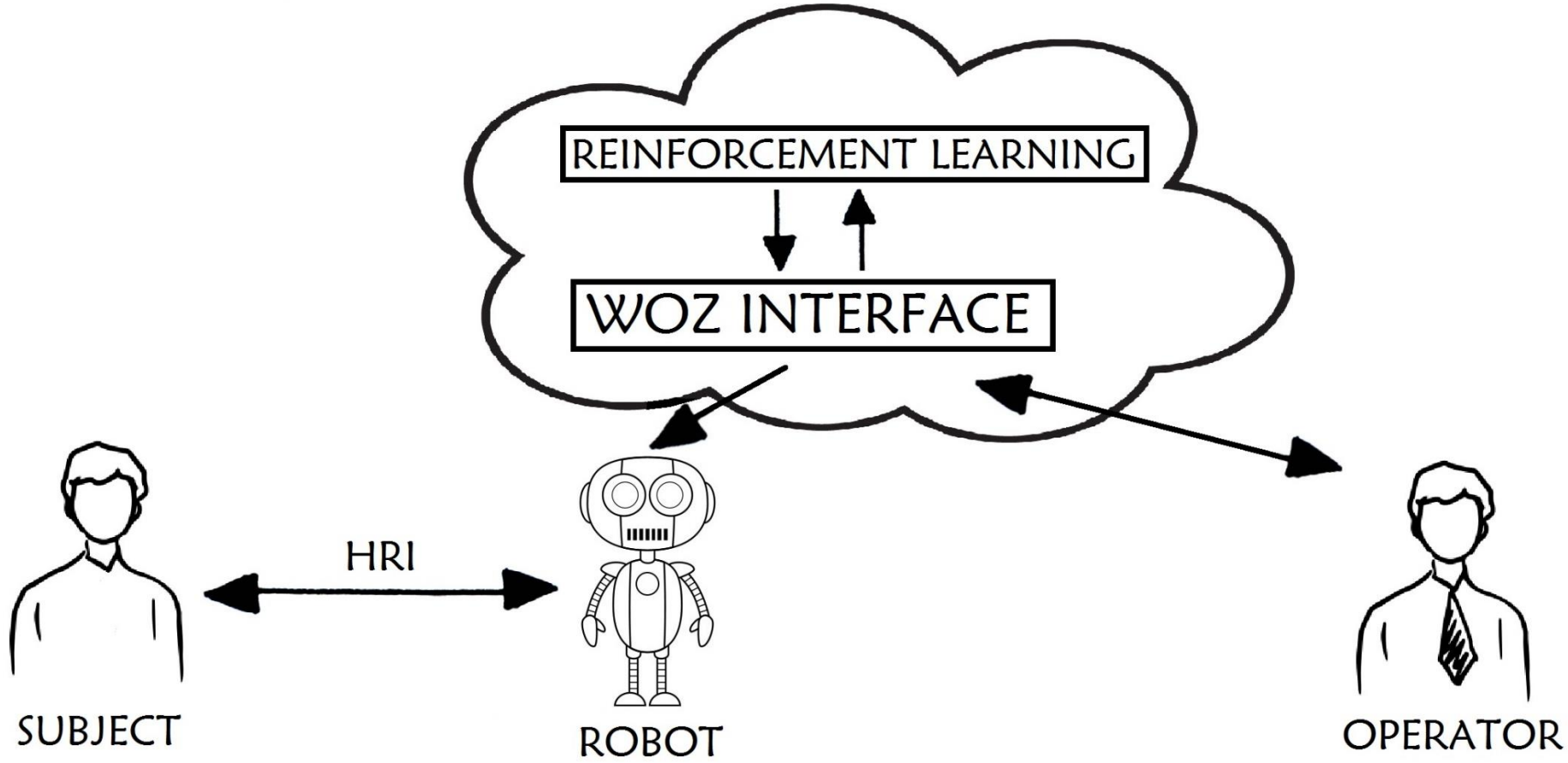
How can social robots help the elderly?

A robot as a coach for cognitive stimulation therapy

PROBLEMS WE HAD TO FACE

- How to control the robot?
- Teleoperators are lazy…
- How to learn?
- How to use cloud computing?

THE OVERALL ARCHITECTURE

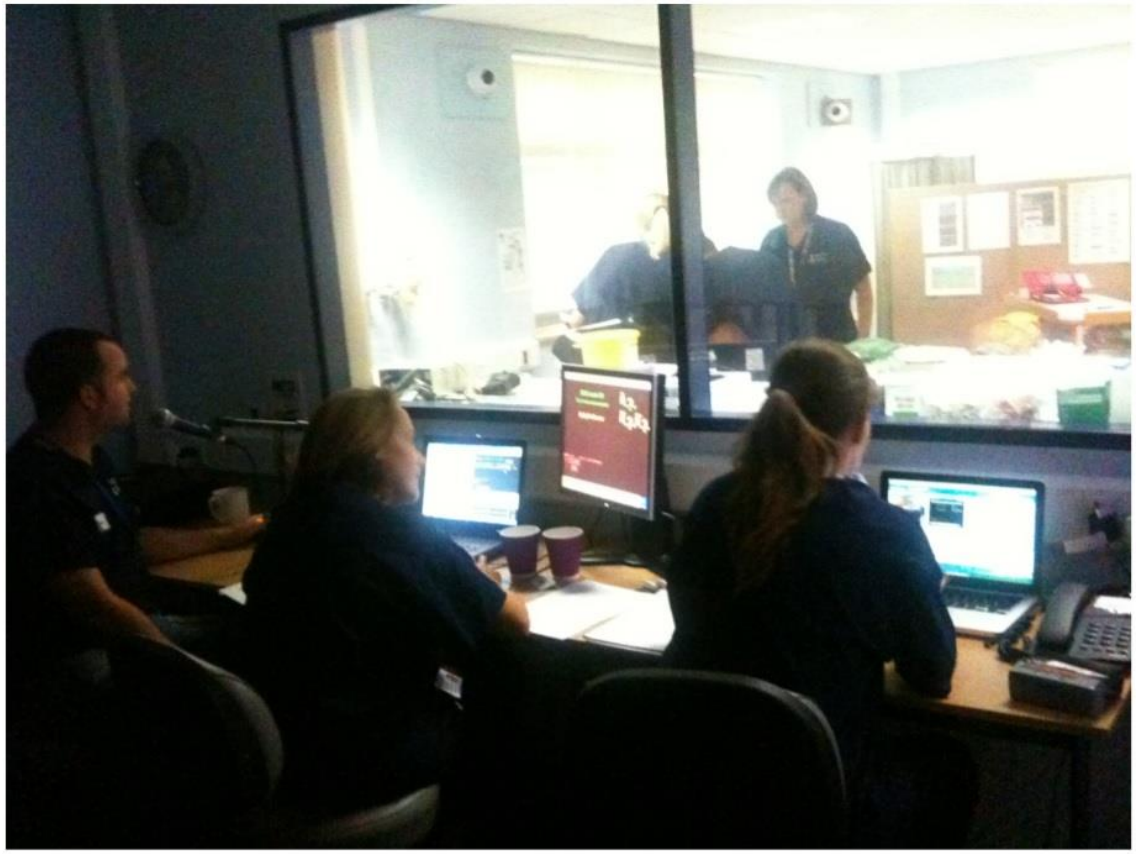


THE WIZARD OF OZ METHOD

"… is a research experiment in which subjects interact with a (computer) system that **subjects believe to be autonomous**, but which is actually being **operated or partially operated by an unseen (hidden) human being.**"

- Hannington & Bella, 2012

THE WIZARD OF OZ METHOD (2)



- Riek, 2012

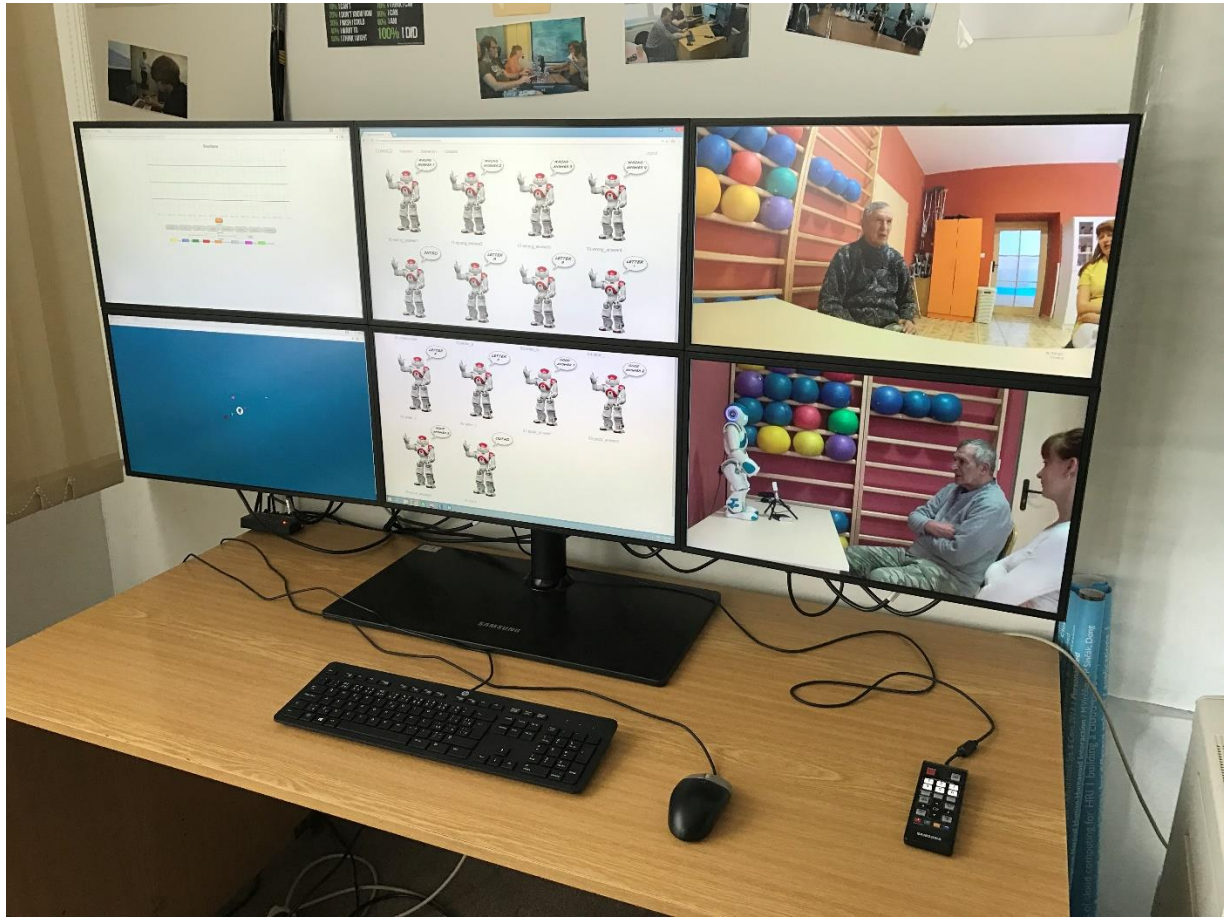
PROBLEMS OF WOZ INTERFACES

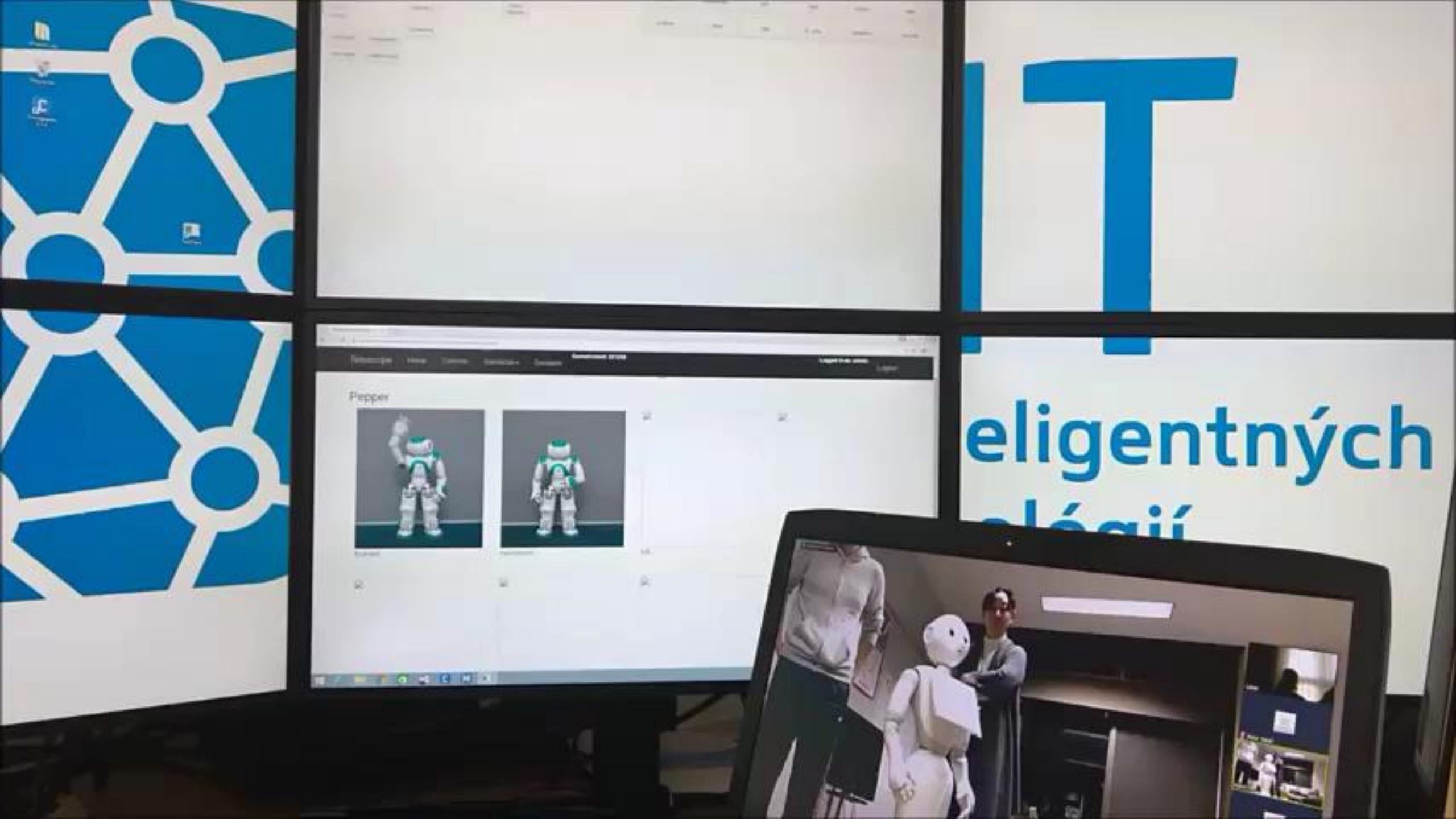
- Different control interface for each scenario
- Incompatible with different types of robots
- Mostly desktop versions
- Installation problems
- Used locally

THE SOLUTION

- ClOud-based Wizard Of OZ (CoWOOZ)
- Same interface for every scenario
- Currently supports: Nao, Pepper, Milo, Q.bo
- Web-based UI
- No installation needed
- Website

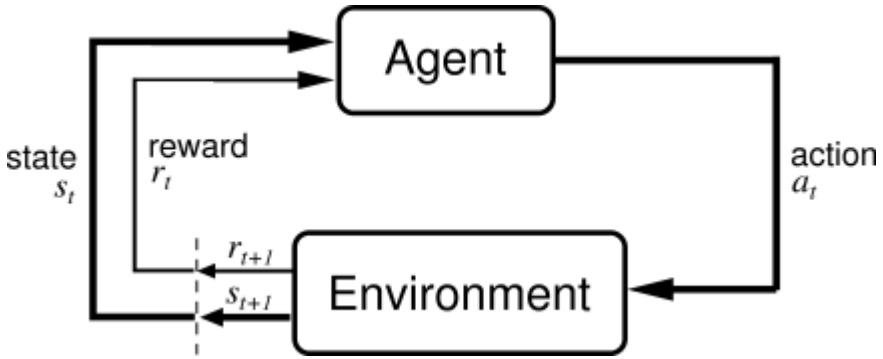
COWOOZ WEB INTERFACE




Pepper
eligentných

REINFORCEMENT LEARNING

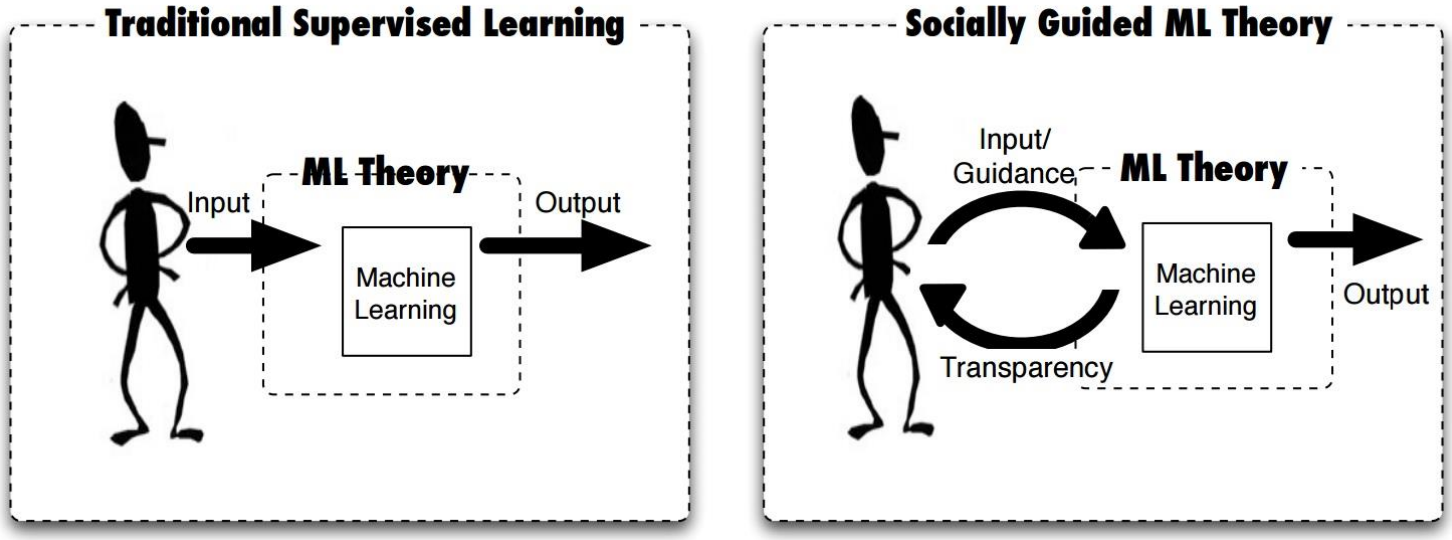
- determines how to map situations to actions
- states, actions, reward function
- Q-table



$$Q = \begin{array}{c} \\ 0 \\ 1 \\ 2 \\ 3 \\ 4 \\ 5 \end{array} \begin{array}{c} \begin{array}{cccccc} 0 & 1 & 2 & 3 & 4 & 5 \end{array} \\ \begin{bmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{bmatrix} \end{array}$$

INTERACTIVE REINFORCEMENT LEARNING

- interactive reinforcement learning
- extension of the classic reinforcement learning technique
- the reward is given by a human, this is called **socially guided machine learning** (A. Thomaz, 2006)



CLOUD-BASED REINFORCEMENT LEARNING

- Publicly available algorithms without the need of installation
- Scalability
- Combine unique models into a general one
- Building a knowledge base by multiple users
- Sharing the knowledge between multiple robots
- Creating personalized robot behavior
- Accessible from the web or locally

COGNITIVE EXERCISES WITH ELDERLY

H1: Our modified interactive reinforcement learning algorithm is able to increase the robot's level of autonomy in a real-world social human-robot interaction scenario.

H2: The elderly will be able to accept and build a positive relationship with the robot even only after two interactions with it.

COGNITIVE EXERCISES WITH ELDERLY (2)

- The participants played two games called “Guess the fruit” and “Guess the animal”
- e.g. Please name a fruit which name starts with A
- The game lasted until the subject gave correct answers for all letters
- 10 subjects (2M/8F, average age 78.5, 68 to 94)

COGNITIVE EXERCISES WITH ELDERLY (3)

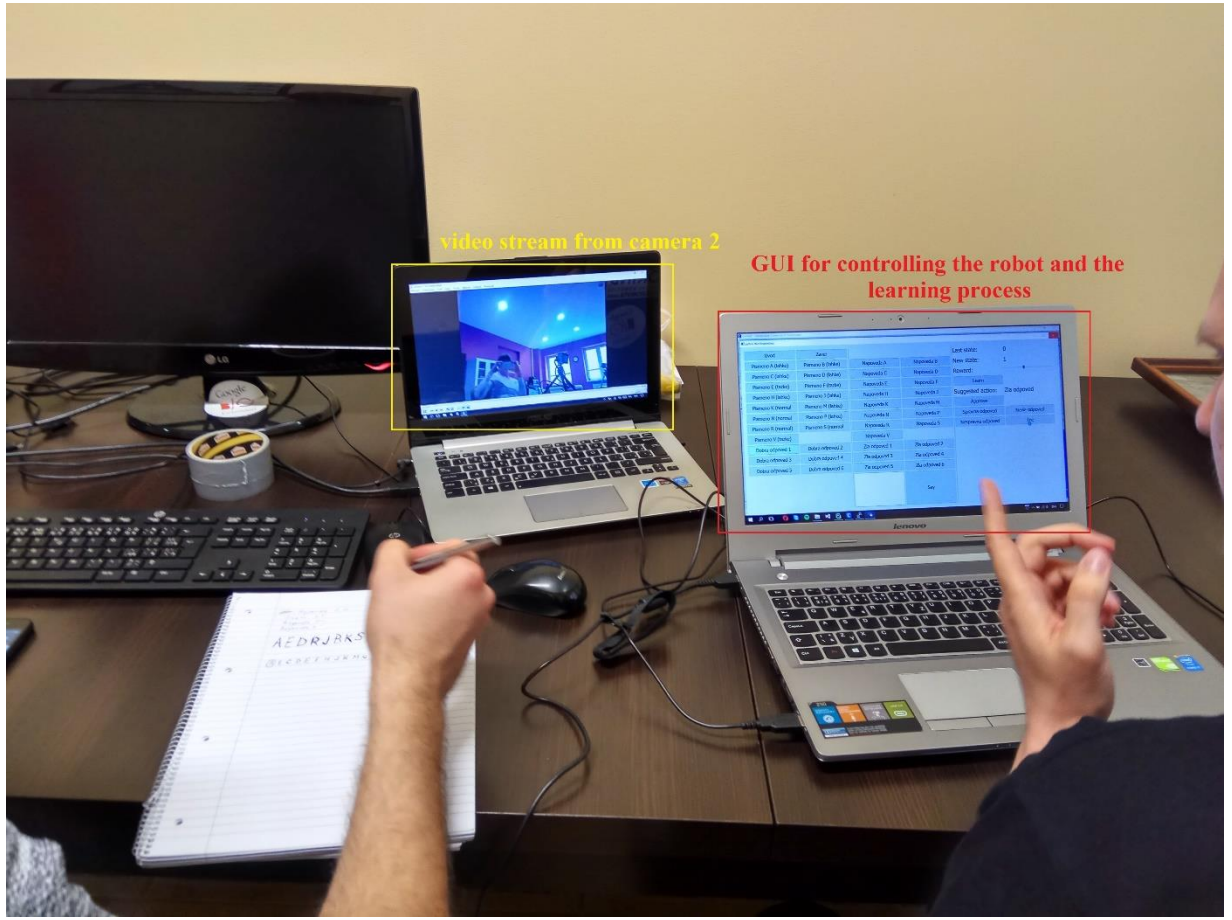
- 4 states: correct answer, incorrect answer, doesn't know, other
- 6 types of actions: easy question, question of medium difficulty, hard question, help, applause, sorrow
- the reward was defined by the teleoperator

COGNITIVE EXERCISES WITH ELDERLY (4)

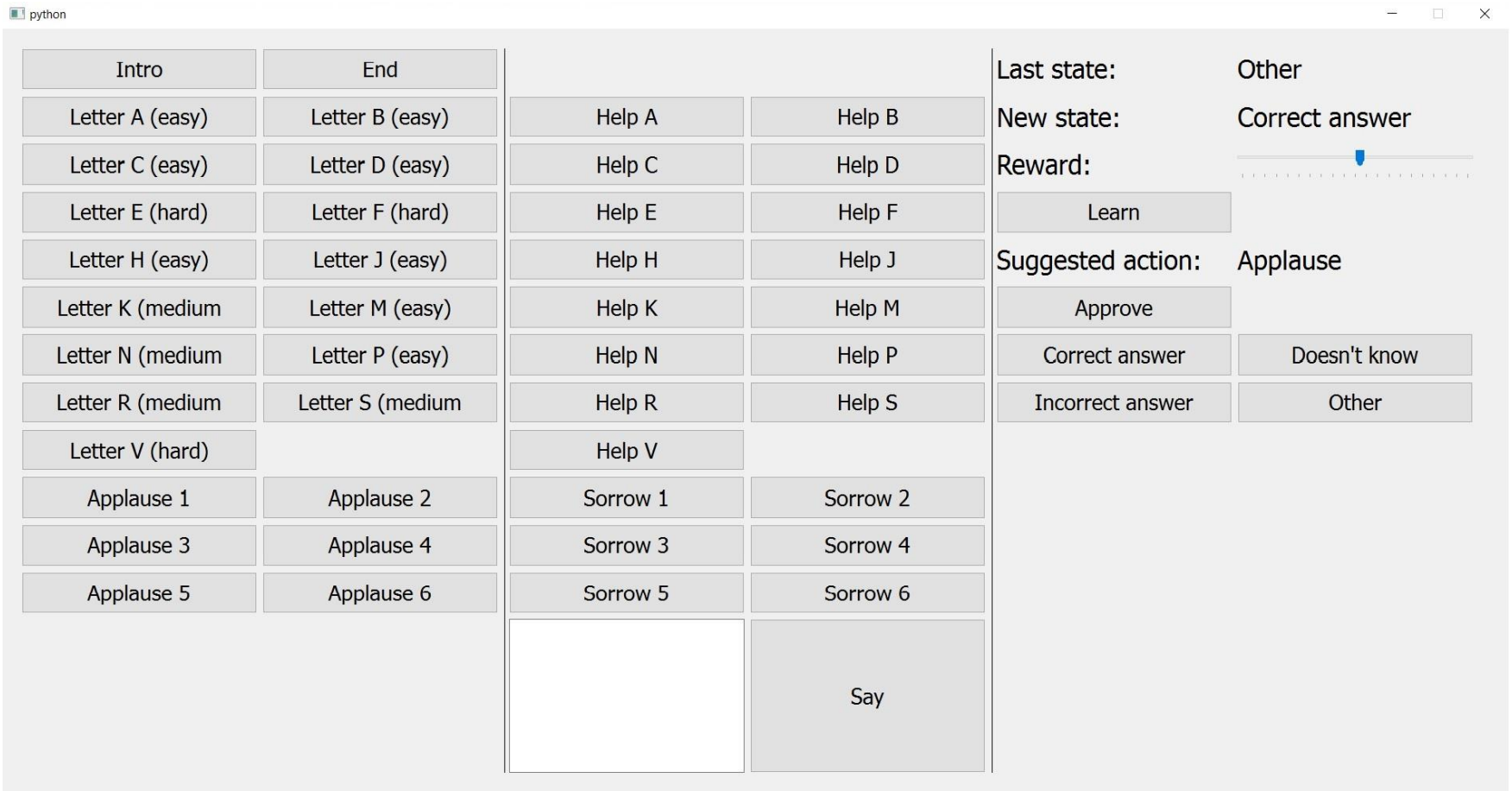
1. Meeting (group) – the participants were introduced to the goal of the experiments
2. Meeting (individual) – the subjects played the cognitive game "Guess the fruit"
3. Meeting (individual) – the subjects played the cognitive game "Guess the animal"
4. Meeting (individual) – the participants filled out a questionnaire about their experience from the sessions

COGNITIVE EXERCISES WITH ELDERLY (5)

COGNITIVE EXERCISES WITH ELDERLY (6)



COGNITIVE EXERCISES WITH ELDERLY (7)



COGNITIVE EXERCISES WITH ELDERLY (8)

s_t = last state, a = action, r = reward

WHILE NOT end of interaction:

  s_t = state of the subject labeled by the Wizard

  a = ε-greedy action selection

  IF Wizard accepts a THEN:

    execute a, label the new state (s_{t+1}) of the subject by the Wizard

  ELSE:

    a = action chosen by the Wizard

    execute a, label the new state (s_{t+1}) of the subject by the Wizard

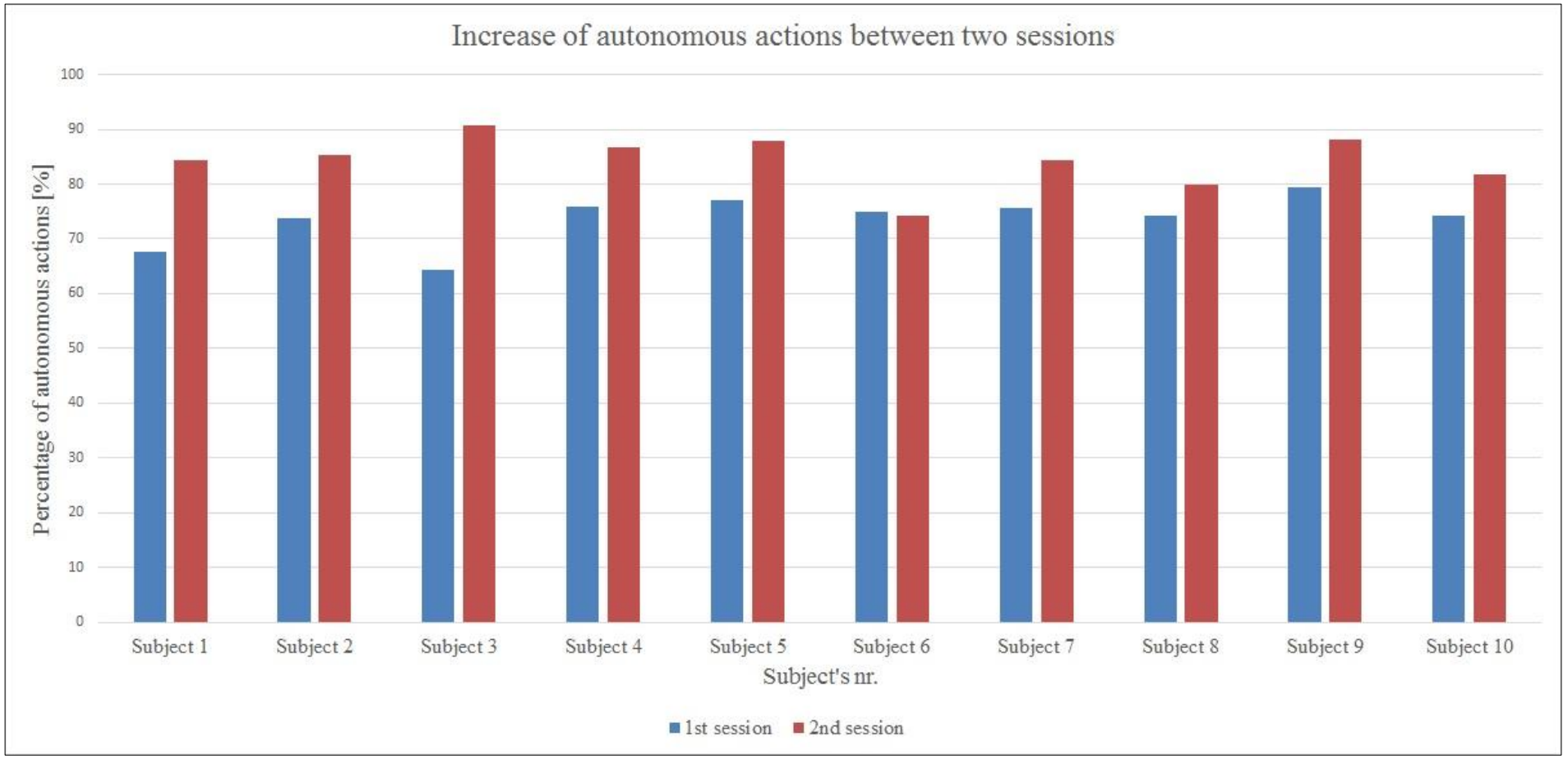
    r = reward given by the Wizard

    update Q-value

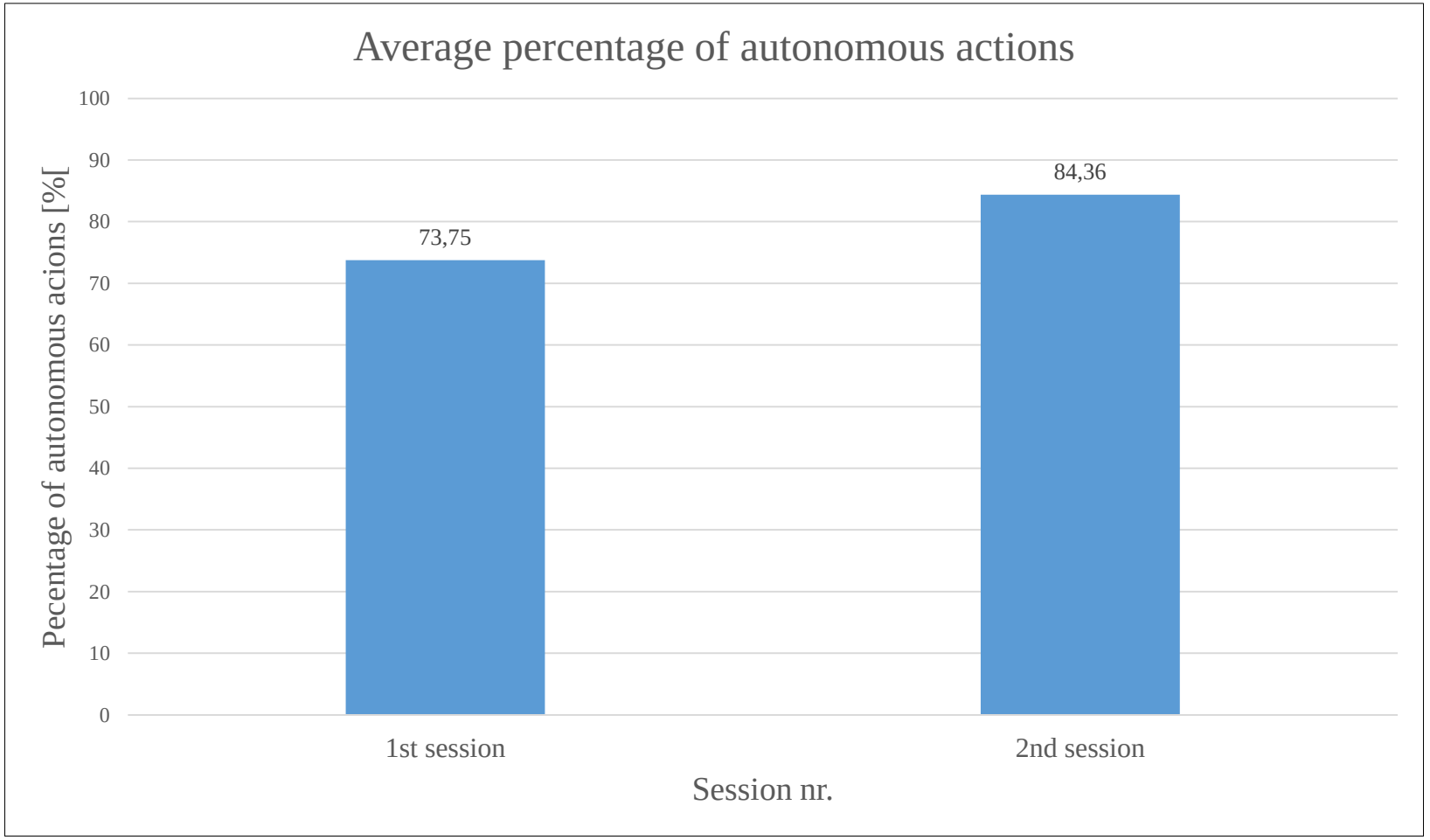
  $s_t = s_{t+1}$

ENDWHILE

COGNITIVE EXERCISES WITH ELDERLY (9)



COGNITIVE EXERCISES WITH ELDERLY (10)



COGNITIVE EXERCISES WITH ELDERLY (11)

- Questionnaire based on the Almere model
- 21 questions
- Filled out by 12 subjects (3M/9F, average age 78.5, 56 to 94)

IF YOU ARE INTERESTED IN …

- Using cloud computing in social robotics
- Application of artificial intelligence in social robotics
- Application of robotics in elderly care

THANK YOU FOR YOUR ATTENTION!

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NA PODPORU
VÝSKUMU A VÝVOJA