Intrinsically Motivated Autonomy in Human-Robot Interaction: Human Perception of Predictive Information in Robots

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Marcus Scheunemann in transit to RoboCup2019

Autonomous robots able to sustain interaction.

Motivation

Idea

Intrinsic Motivation to generate robot behaviour.

Test Intrinsic Motivation in HRI context.

General Hypothesis:

- Increased markers for agency and other lifelike properties.

- Leading to more interest in interaction.

Intrinsic Motivations

… related to core elements of agency.

Usual properties:

- Robustness

- Task-Independence

- Semantic Independence

- Universality

Predictive Information

Maximise mutual information between your past and future sensors.

Conceptually: Control your own future while also experiencing a diversity of sensor states.
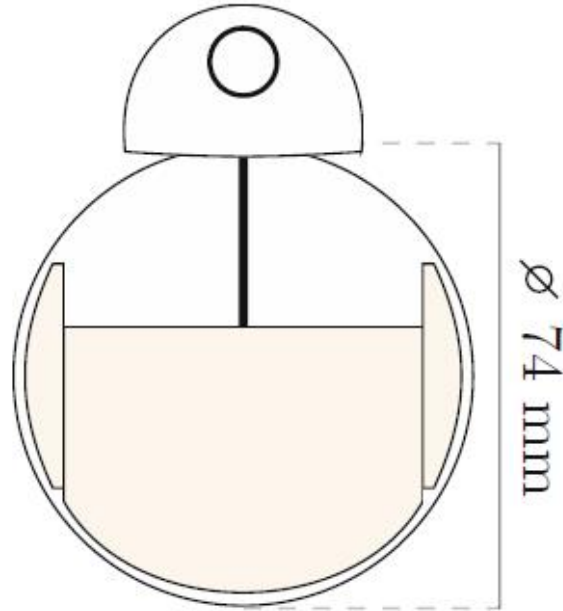
Implementation follows:

Martius, G., Der, R., Ay, N.: Information driven self-organization of complex robotic behaviors. PLoS one 8(5), 1–14 (2013).

A normal   B bungee   C high bar   D pit
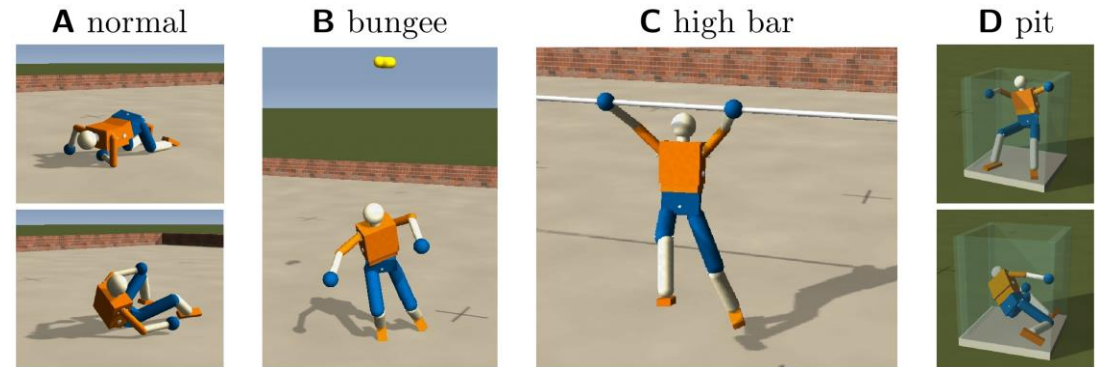
- Playful behaviour (human perception)
- Sensitive to Embodiment
- Reactive to outside stimuli
- Applicable to range of robots

Existing application to ball-like robot (in simulation)

- Sphero BB8

- Motors:
- 2 servo-wheels inside the ball
- Sensors:
- 3 DOF accelerometer
- 3 DOF gyroscope
- Servo position and speed

Our Robot

Conditions to Compare

ADA:

Robot controlled by

neural network

that gets updated with

preditive information maximising

learning rule.

REA:

Baseline:

- ~~Random~~

- ~~Human Controller~~

- Reactive Controller
  - Neural network, preadapted, but not adapting during trial.

Experimental Setup

Order REA, ADA randomized.

Questionnaires after each condition.
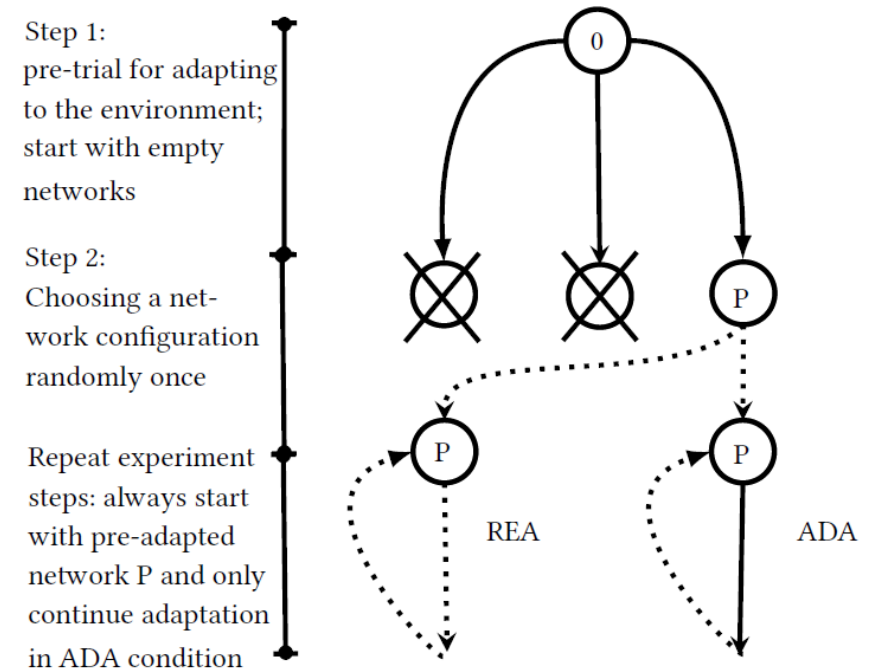
16 participants, 5 female, 11 male.

Figure 3: We chose a network configuration P from three 5 minute pre-adaptation trials for the starting point of each condition. Only during the ADA condition the adaptation continuous during the human-robot interaction trial.

Experimental Setup

Interaction area with obstacles.

- Open towards the participant.
- Participants encourage to keep robot from falling.
- Robot can be touched, which is demonstrated.

Trials last for 5 minutes.
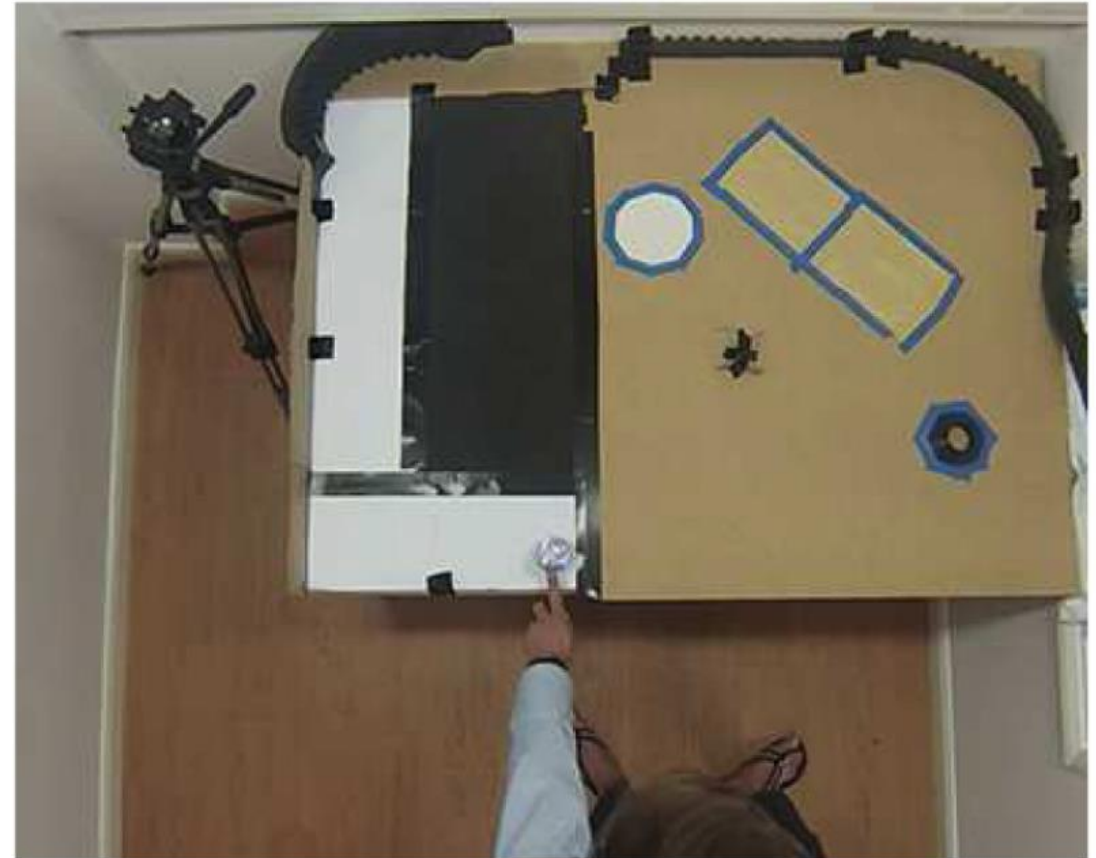
Questionnaires

Godspeed:
- Anthropomorphism
- Animacy
- Likeability
- Perceived Intelligence
- Perceived Safety

Robotic Social Attributes Scale (RoSAS),

relatively new, 7 Likert Scale:
- Warmth
- Competence
- Discomfort

Open Questions:

(1) Can you describe the different behaviours of the robot? Did the robot have any particular strategy for exploring?

(2) What were the best and/or worst aspects of the robot's behaviour?

Factor	95% confidence interval		p	r
	Lower bound	Upper bound		
Anthropomorphism	−0.3	0.4	0.916	0.037
Animacy	−0.25	0.333	0.69	0.141
Likeability	−0.3	0.4	0.726	0.124
Perceived intelligence	−0.2	0.8	0.244	0.412
Perceived safety	−0.667	0.667	0.444	0.271
Warmth	−0.667	0.167	0.366	0.32
Competence	−0.583	0.5	0.798	0.09
Discomfort	−0.833	0.083	0.141	0.52

Wilcoxon Signed Rank Test between REA and ADA

- No significant p-values
  - Small sample size
- Effect Size (r)
  - Perceived Intelligence, for REA
  - Warmth and Discomfort, for ADA

Results

Upcoming Publications

Successful follow up studies:

New Task: Differentiate between
the different robots.

New Interaction Tool that allows
for detection of human.

Results for Discomfort and
Warmth.

Acknowledgments

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