Robotics Reading Group
@ Instituto Superior Técnico

Session #6
17-01-2020

Filipa Correia

Outline

1. Which paper is it?
    a. Why did I choose it?
2. Brief overview of the paper
    a. Mainly for those that could not read the paper
3. Discussion and exercises on the topic!
    a. Say your opinions and ideas!
    b. Interrupt!
    c. Have fun!

1. Which paper is it?

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

Authors: Marcus M. Scheunemann, Christoph Salge, and Kerstin Dautenhahn

In: Towards Autonomous Robotic Systems, 325–337. Cham, 2019. Springer

Why did I choose this paper?!

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

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Intrinsic Motivation @ GAIPS

FAtiMA Modular: Towards an Agent Architecture with a Generic Appraisal Framework

João Dias, Samuel Mascarenhas, Ana Paiva

Learning by Appraising:

An Emotion-based Approach to Intrinsic Reward Design *

Pedro Sequeira Francisco S. Melo Ana Paiva

Generating Norm-related Emotions in Virtual Agents

Nuno Ferreira[1], Samuel Mascarenhas[1], Ana Paiva[1], Frank Dignum[2], John Mc Breen[3], Nick Degens[3], and Gert Jan Hofstede[3]

Using Empathy to Improve Human-Robot Relationships

André Pereira, Iolanda Leite, Samuel Mascarenhas, Carlos Martinho, and Ana Paiva

Can an agent be social when alone? An experimental study on adaptive behaviour and its motivations

Diogo Rato, Marta Couto, Samuel Mascarenhas, Rui Prada

IN SUBMISSION

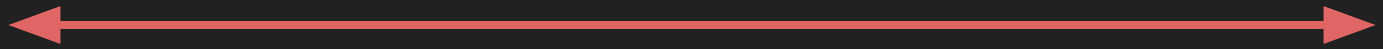
We will revisit this slide in the end...

2. Brief overview of the paper

Intrinsically Motivated Autonomy

Intrinsically Motivated Autonomy

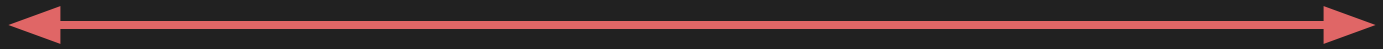
Intrinsically Motivated Autonomy



Teleoperation

- No human in control
- Low adaptability (if scripted…)

Intrinsically Motivated Autonomy



Teleoperation

- Adaptability
- Low Scalability
- Human bias

Intrinsically Motivated Autonomy

Intrinsically Motivated Autonomy

“general heuristic (i.e. motivation function)”

Intrinsically Motivated Autonomy

"general heuristic (i.e. motivation function)"

"Once we identify something as an agent, we are likely to direct our attention towards that agent, trying to understand its goals, intentions and behaviour."

What kind of behaviour makes a robot interesting?

Research Question:

- “What is a good heuristic if my robot knows nothing about the world or even its own morphology?”
  - Curiosity
  - Self-maintenance
  - Self-learning
  - Companionship

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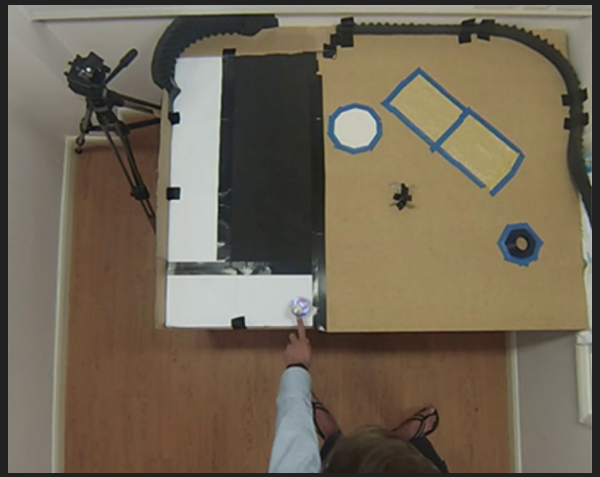
Predictive Information

- Reduction of the time prediction error in the perception-action loop
- To maximise the mutual information between the robot's past and future sensor states
  - One neural network to generate behaviour from sensor input
  - Another neural network to predict future states

Martius, Georg, Ralf Der, and Nihat Ay. "**Information driven self-organization of complex robotic behaviors**." PloS one 8.5 (2013): e63400.

User study

- Observe the robot and understand whether it has a strategy for exploring the environment
- Prevent it from falling off the table



User study

Reaction to sensor input (motion)

Reactive condition

Adaptive condition

User study

Reaction to sensor input (motion)

Reactive condition

Adaptive condition

- Behaviour is motivated by maximising the predictive information and it continuously updates its internal networks during the experiment

User study

Reaction to sensor input (motion)

Reactive condition

- Starts with the same networks as the adaptive one (pre-trial), but it does not further update the networks during the experiment

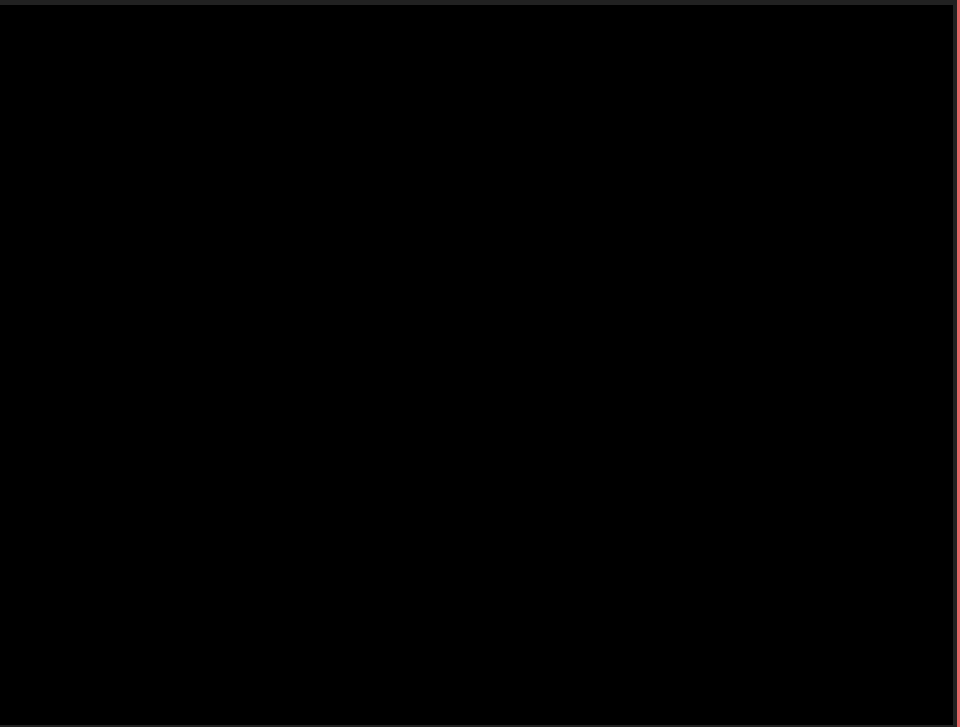
Adaptive condition

- Behaviour is motivated by maximising the predictive information and it continuously updates its internal networks during the experiment

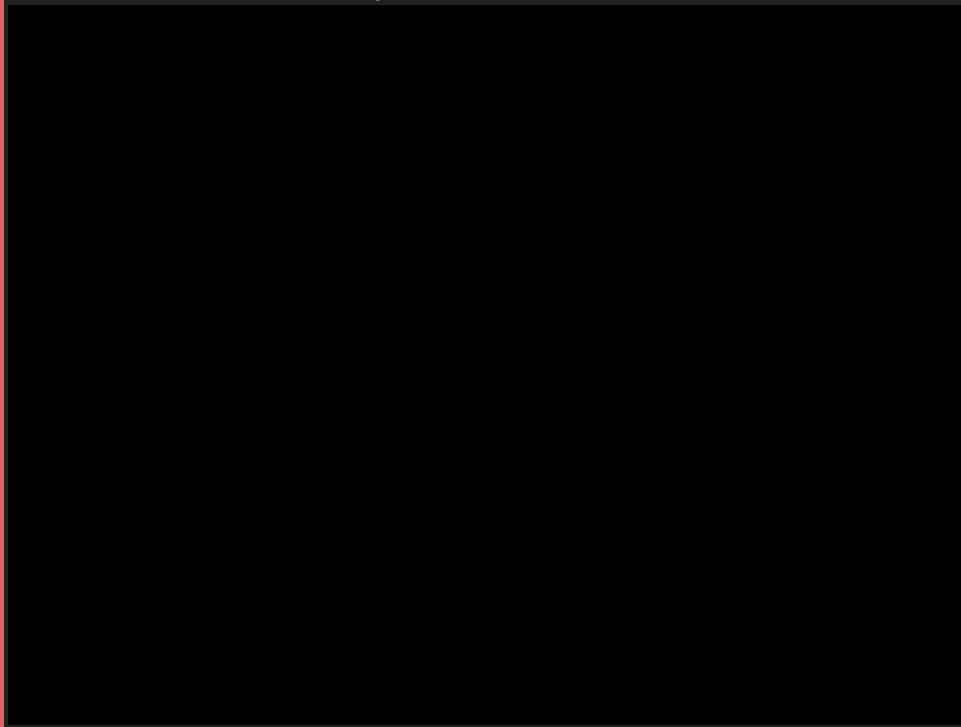
User study

Reaction to sensor input (motion)

Reactive condition



Adaptive condition



https://mms.ai/TAROS2019-supplementary/

Results

Perceived Intelligence:

- REA > ADA

Warmth & Discomfort:

- ADA > REA

Table 1. Wilcoxon Signed Rank Test results between *REA* and *ADA*

	95% confidence interval			
factor	lower bound	upper bound	p	r
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

Results

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- REA > ADA

Warmth & Discomfort:

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P-value VS effect size ?!

- …

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3. Discussion and exercises on the topic!

What kind of behaviour makes a robot interesting?

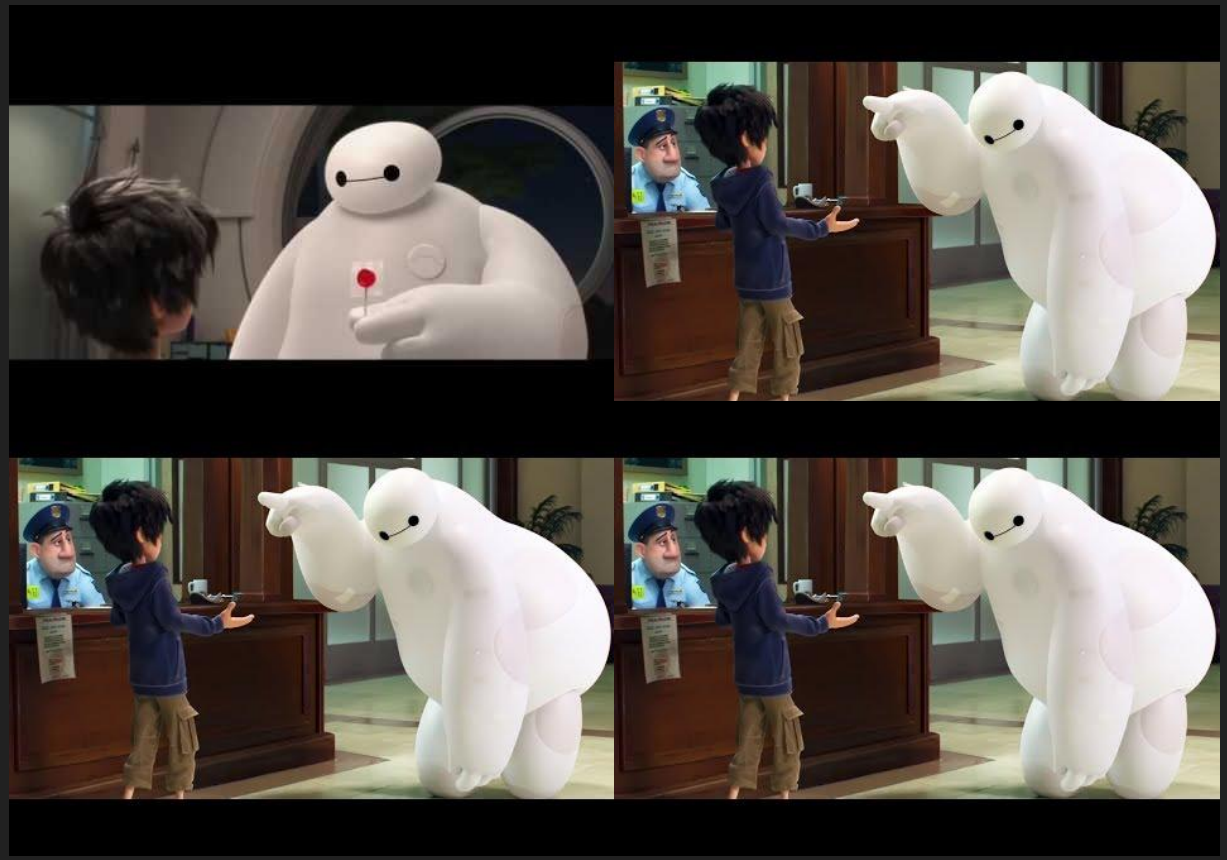
What should the intrinsic motivations of a robot be?

What kind of behaviour doesn’t make a robot interesting?

Jibo

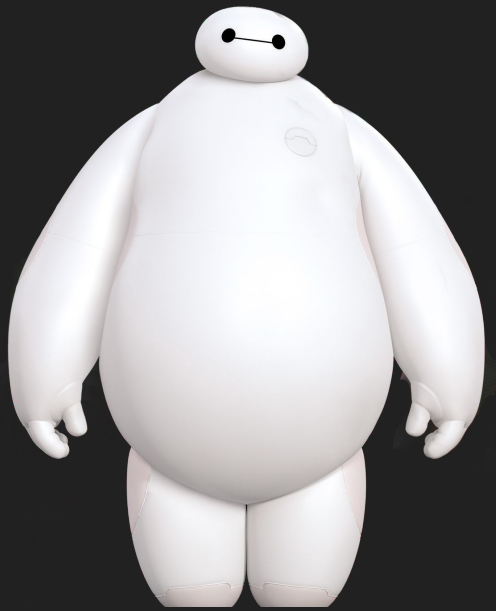
ElliQ by Intuition Robotics

What kind of behaviour makes a robot interesting?



What is(are) Baymax intrinsic motivation(s)?

- [No time to discuss]



What should the intrinsic motivations of a robot be?

- Do they depend on the possible actions or modalities of the interaction?
- Have (several) goals
- Perceive humans' goals
- Memory
- Should we mimic human-human interaction?

Motivations:

- Obey the master
- Taking care of the master / empathy
- "Do no harm"
- Self preservation
- Curiosity (dependent on the context/task)

How should the robot manage several motivations?

- [No time to discuss]

Technical issues, requirements, advances, ...

- [No time to discuss]

Happy New Year!