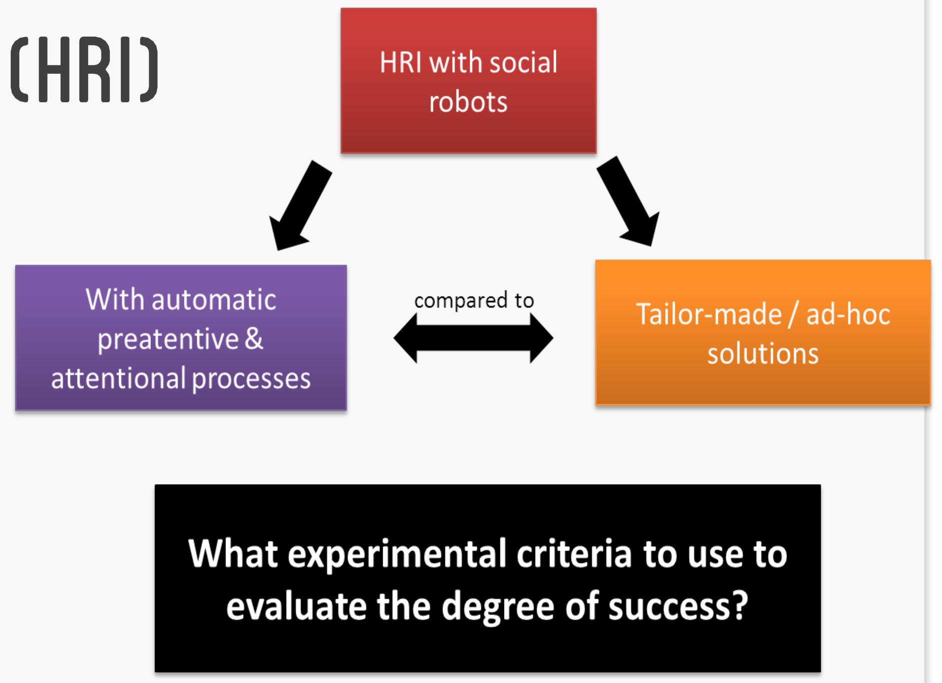
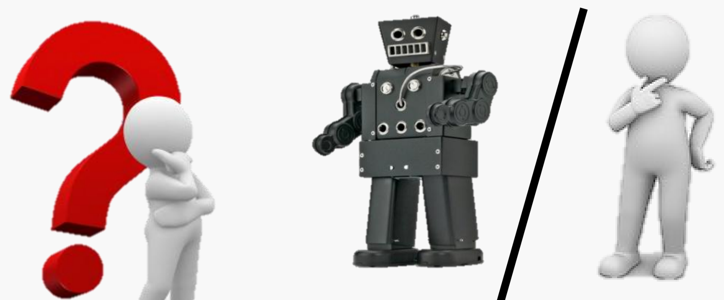
EVALUATING THE INFLUENCE OF AUTOMATIC ATTENTIONAL MECHANISMS IN HUMAN-ROBOT INTERACTION

Pablo Lanillos, João Filipe Ferreira, Jorge Dias

EVALUATING HUMAN ROBOT INTERACTION (HRI)

The hypothesis is that using automatic attentional mechanisms as a basic block for posteriorly build a robotic cognitive intelligence is the correct approach and, in order to experimentally prove it, we propose a systematic evaluation method.





Turing test for social skills

systematic evaluation criteria

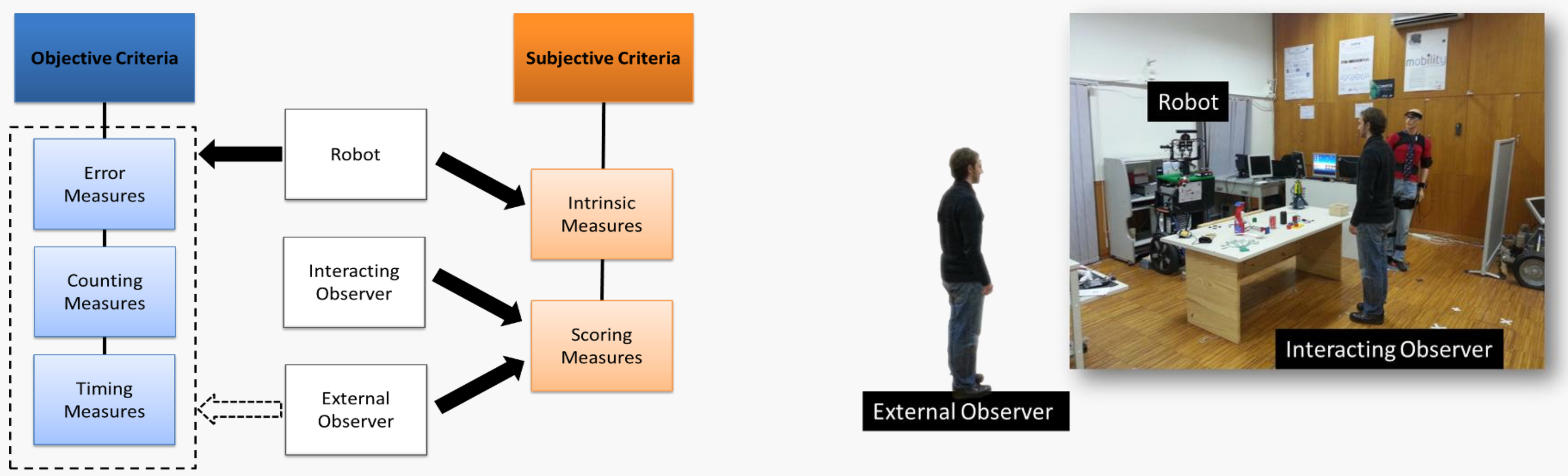
⬇

HRI benchmarking

Social Compliance Score (SCS) as an unique value to evaluate the robot behavior. X is the SCS of using attentional process and Y is the SCS of using a tailor -made solution, then we state:

$$H0: X > Y \rightarrow attention\ mechanisms\ better\ than\ tailor-made\ for\ HRI$$

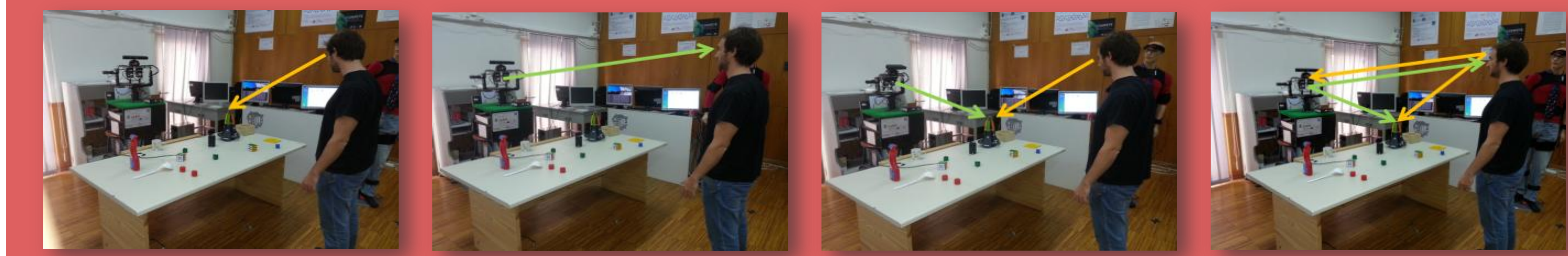
OBSERVERS



ROBOT CLASS DEPENDING ON ITS CAPABILITIES

A	robots capable of gaze-shifts and fixation (e.g. active head)
B	robots with speech capabilities. B1 speech recognition and B2 able to talk
C	robots with arms and pointing or showing capabilities
D	robots with emotional capabilities

JOINT ATTENTION AS THE REFERENCE FRAME



CRITERIA

Evaluation bridge conventional objective measures from robotics with subjective criteria from human studies in psychology and neuroscience.

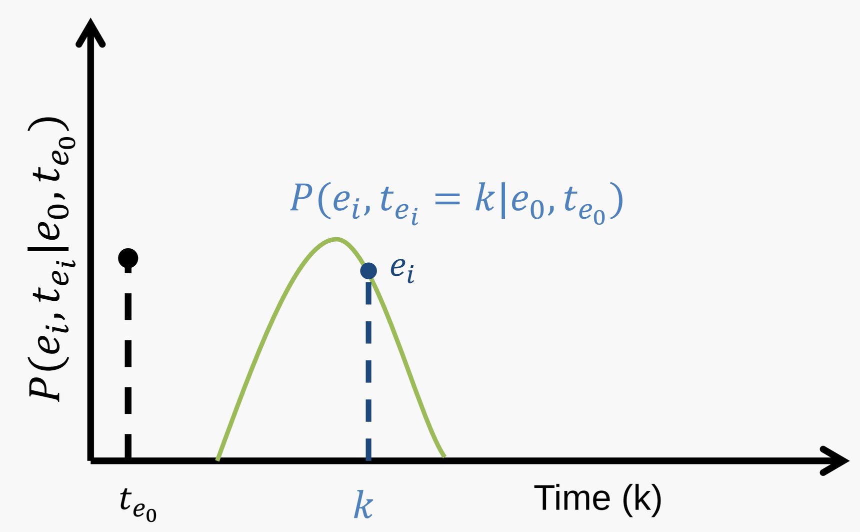
Objective

items	ID	Robot Class
Qualitative Criteria in Reciprocal Social Interaction		
Engaging and Joint Attention		
Interlocutor detection error	RSI1	A
Robot engaging delay after human IJA	RSI2	A
Disengaging delay after human pointing or gazing	RSI3	A
Object search latency	RSI4	A
Acknowledging joint attention period or cycle	RSI5	A
#Engages	RSI6	A
#Disengages	RSI7	A
#Robot initiating joint attention (IJA)	RSI8	A
#Pointing events	RSI9	C
#Showing events	RSI10	C
Looking at people frequency	RSI11	A
Object detection success	RSI12	A
Joint attention error	RSI13	A
Turn taking coherence (IJA switching)	RSI15	A
Social-emotional reciprocity		
Expressions towards interlocutors rate	RSI16	D
Frequency of contact (touching)	RSI17	C / CD
Restricted, Repetitive Behaviors and Interests		
Contingent stimulus attention error	RB1	A / B2 / D
Time to attend novel contingent multimodal stimulus	RB2	A / B / C / D
Head movements per second	RB3	A
Social delay error	RB4	A / B / C / D
Qualitative impairments Communication and Language		
Utterances rate per interlocutor	CL1	B1
Name hearing error	CL2	B1
Frequency of vocalization directed to others	CL3	B2
HRI performance metrics		
Reciprocal Social Interaction	R_o	-
Behaviors and Interests	B_o	-
Communication and Language	C_o	-

Subjective

items	ID	Robot Class
Qualitative Criteria in Reciprocal Social Interaction		
Engaging and Joint Attention		
Unusual eye contact	JA1	A
Low frequency of looking at people	JA2	A
Spontaneous initiation of joint attention	JA3	A / B2
Pointing	JA4	C
Showing	JA5	C
Looking at object	JA6	A
Acknowledging joint attention	JA7	A / B2 / C
Social reward		
Shared enjoyment	SR1	D
Social-emotional reciprocity		
Facial expressions directed to others	ER1	D
Quality of social overtures	ER2	D
Use of other's body to communicate	ER3	C / CD
Restricted, Repetitive Behaviors and Interests		
Repetitive interests and behaviors	RB1	A / B / C / D
Unusual sensory behaviors or interest	RB2	A / B / C / D
Overactivity	RB3	A / B / C / D
Negative behavior and distraction	RB4	A / B / C / D
Slow behavior	RB5	A / B / C / D
Qualitative impairments Communication and Language		
Conventional gestures	CL1	A / C
Response to name	CL2	B1
Frequency of vocalization directed to others	CL3	B2
Immediate echoing	CL4	B2
Speech abnormalities	CL5	B2
HRI performance metrics		
Reciprocal Social Interaction	R_s	-
Behaviors and Interests	B_s	-
Communication and Language	C_s	-

EXPECTED BEHAVIOR



Subjective scores should be correlated with the objective measures.

The expected behavior can:

- Be learned from human data
- Be used as an error function criteria by comparison with the real robot behavior

SOCIAL COMPLIANCE SCORE

Objective (O) = $\{R_o, B_o, C_o\}$

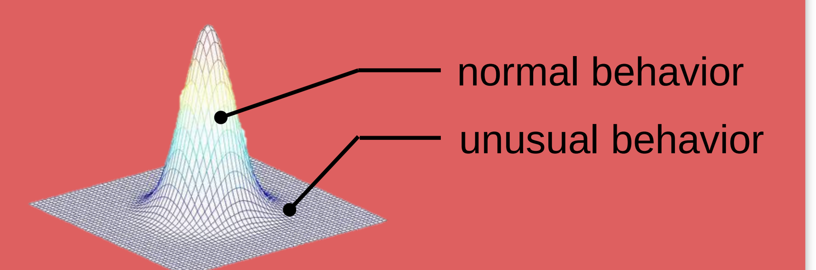
Subjective (S) = $\{R_S, B_S, C_S\}$

- Reciprocal social interaction
- Behaviors and Interests
- Communication and language

$$\mathbf{SCS = P(human|[O\ S], \Theta)}$$

- One-Class classification
- Anomaly detection

[Tax 2001, Chandola 2009]



REFERENCES

Tax, D. M. J. (2001), 'One-class classification: Concept learning in the absence of counter-examples', PhD thesis, Technische Universiteit Delft.

Chandola, V., Banerjee, A., Kumar, V. (2009). 'Anomaly detection: A survey'. ACM Comput. Surv.

COMPETE
QREN
UNIÃO EUROPEIA Fundo Europeu de Desenvolvimento Regional
FCT Fundação para a Ciência e a Tecnologia
CASIR
FCOMP-01-0124-FEDER-028914
PTDC/EEI-AUT/3010/2012

ARTIFICIAL PERCEPTION TEAM FOR INTELLIGENT SYSTEMS AND ROBOTICS
INSTITUTO DE SISTEMAS E ROBÓTICA UNIVERSIDADE DE COIMBRA
UNIVERSIDADE DE COIMBRA

4/15/2014