

ReGround:

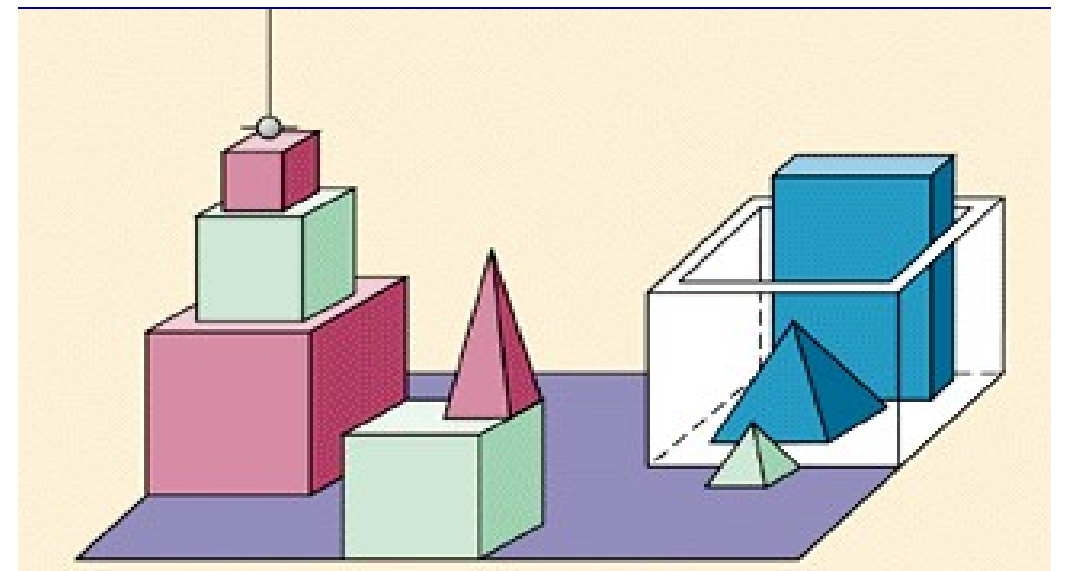
Relational Symbol Grounding through Affordance learning



Winograd's SHRDLU [1968-70]

Micro-world in simulation

- dealing with blocks,
- natural language,
- simple planning and reasoning.



Put the blue pyramid on the block in the box

Assumed symbol grounding problem was solved

Reground: Winograd's setting in the real world



Bring me the tea pot and the sugar

Koç University



- Private research university with English instruction in Istanbul founded 1993.
- 4000 undergrad, 600 grad, 400 faculty.
- Ranked 36th worldwide among young universities by [Times Higher Education](#).
- Among top 3 Turkish universities in publication rate and grants awarded.



Koç University ReGround Team

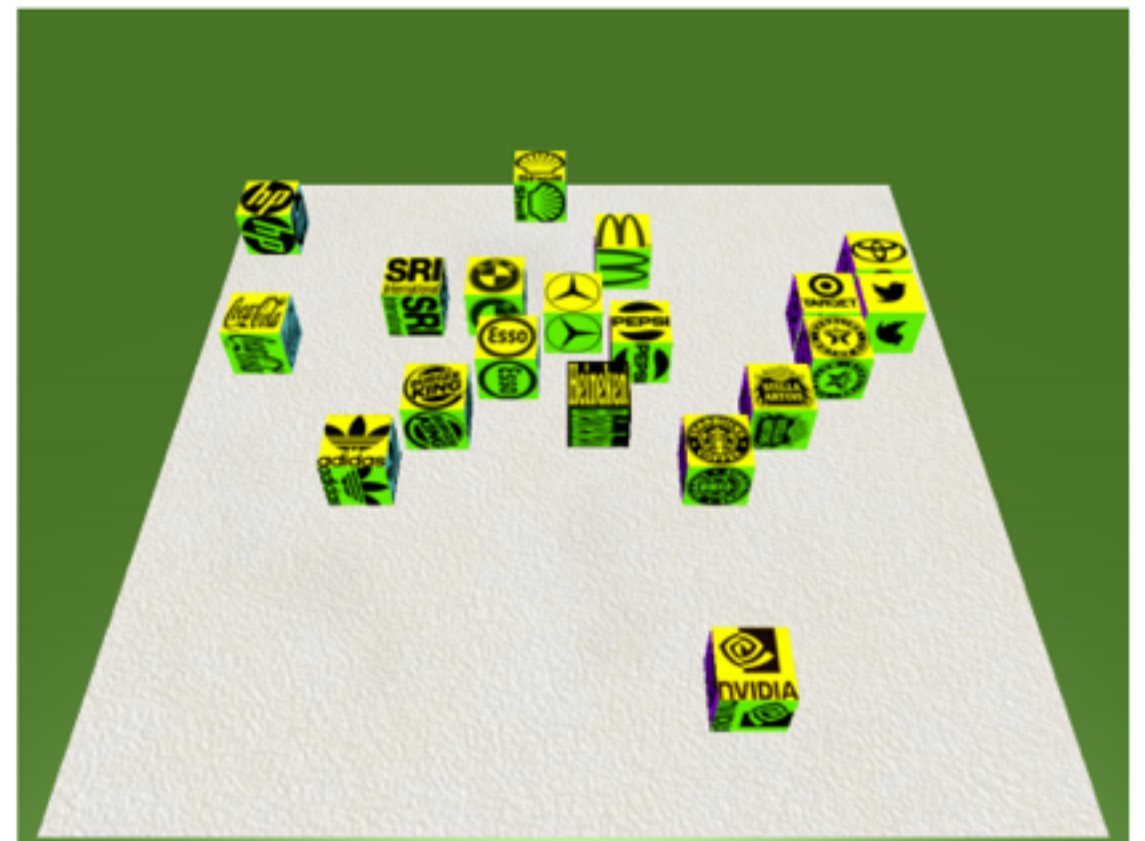


- Deniz Yuret
 - NLP, ML
- Yücel Yemez
 - Vision, Graphics
- Aylin Küntay & Tilbe Göksun
 - Language development



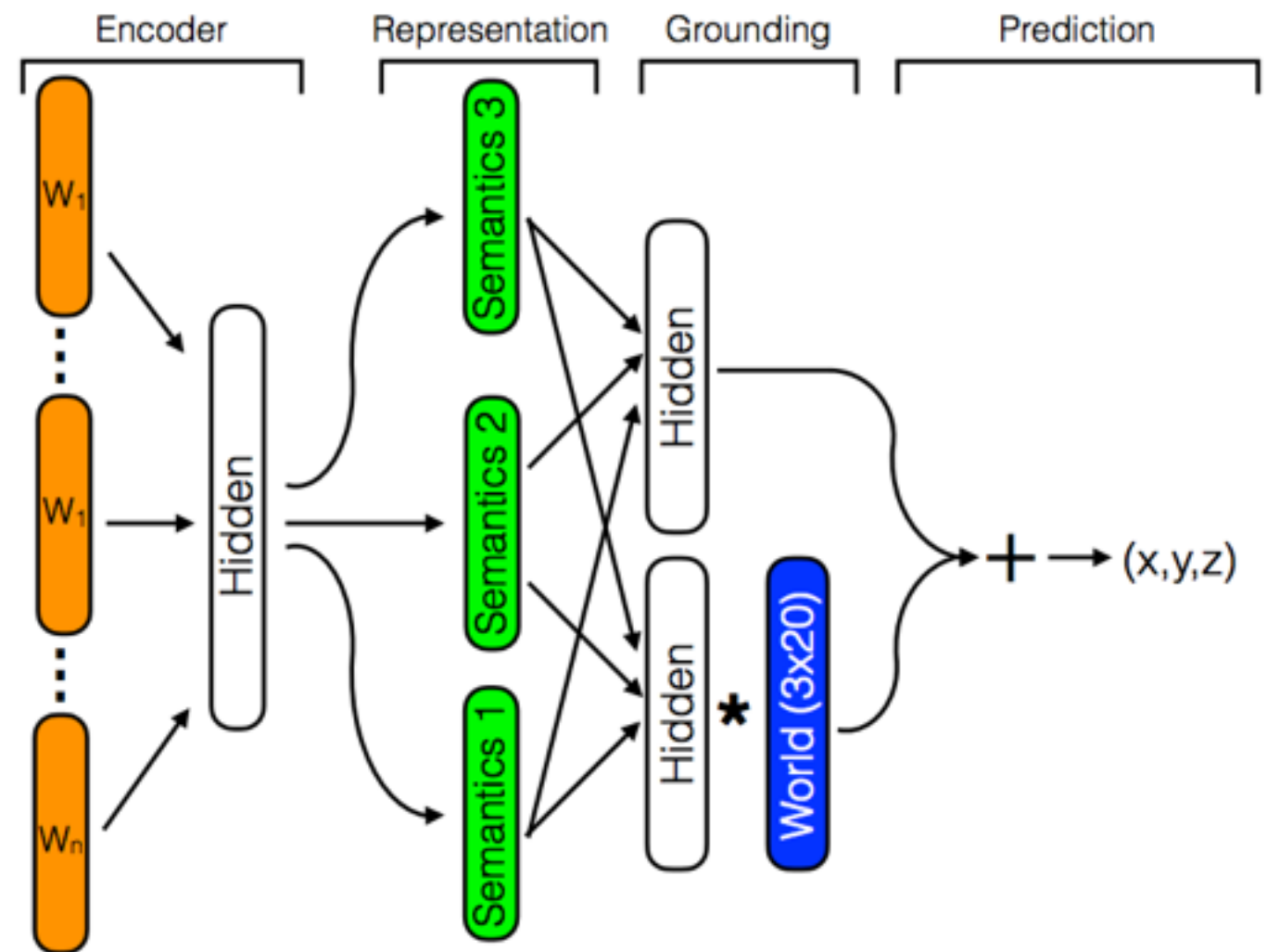
Koç/ISI joint work on a language grounding dataset

- Goal: learning to understand spatial instructions in a blocks world setting.
- Example: “Place the BMW block to the right of Adidas.”
- The dataset consists of before/after images and instructions from Amazon Turkers.



Learning Architecture

1-Hot word vectors (orange) are fed as input to a Feed Forward or Recurrent Neural Network for encoding. A semantic representation is extracted (green), which in conjunction with knowledge of the world (blue) is grounded to predict an action.



Örebro University

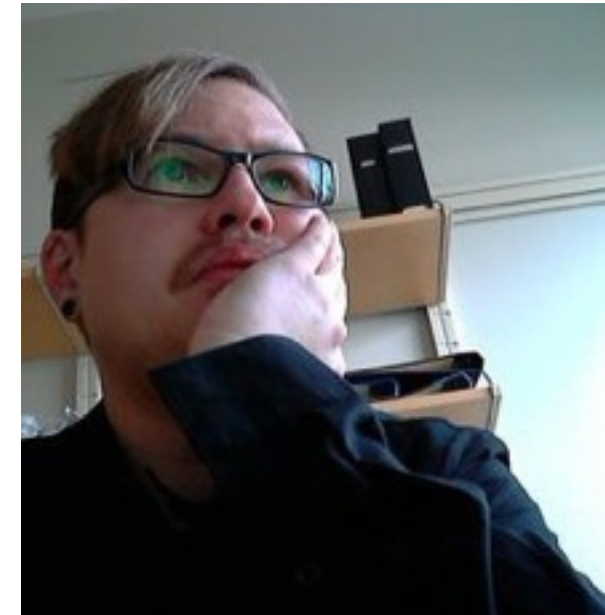
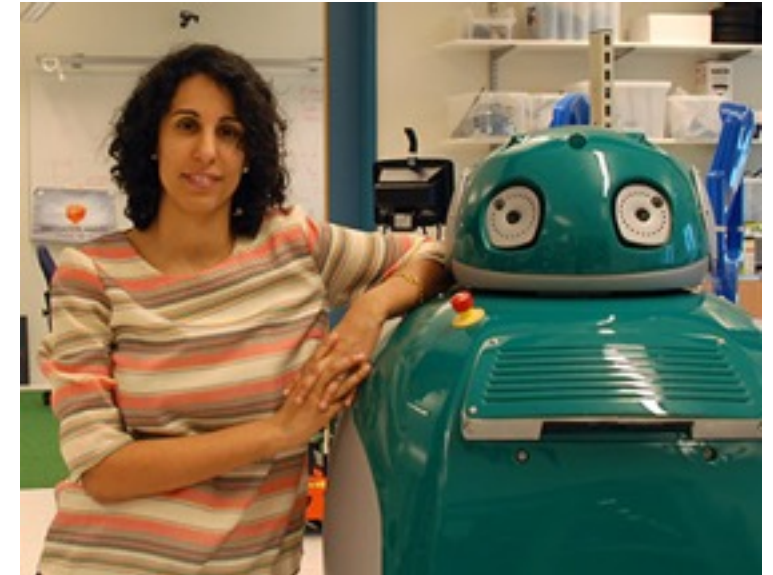
- University status since 16 years.
- 17000 undergrad, 500 doctoral students, 1300 staff.
- Ranked 63rd worldwide among young universities by [Times Higher Education](#).



Örebro University



- Alessandro Saffiotti :
robotics, AI
- Amy Loutfi & Andreas
Perrson & Jasmin
Grosinger: anchoring



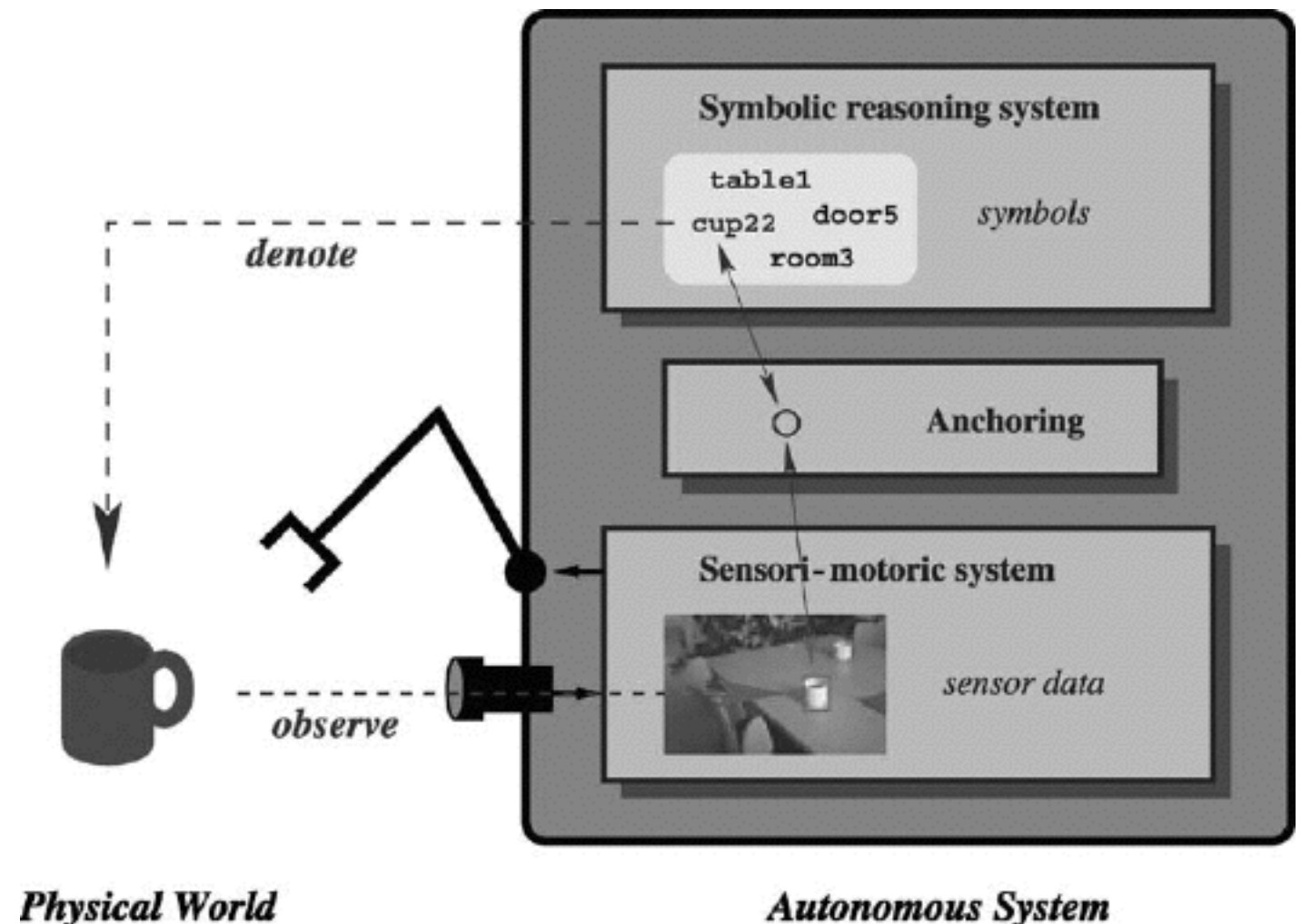
Perceptual Anchoring

“Anchoring is the problem of connecting, inside an artificial system, symbols and sensor data that refer to the same physical objects in the external world.”

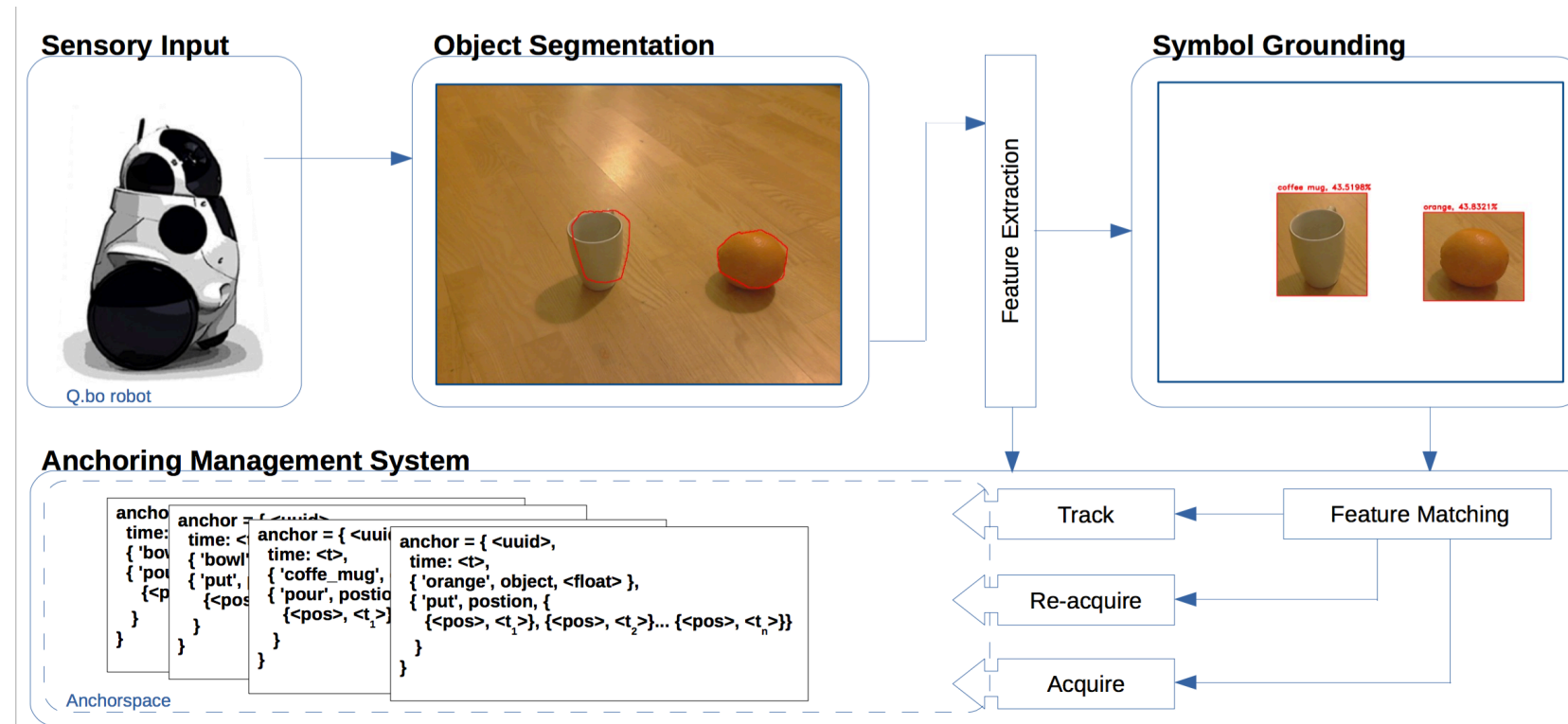
*S. Coradeschi and A. Saffiotti.
Robotics and Autonomous Systems
43(2-3):85-96, 2003.*

Related to both *pattern recognition*
and *symbolic grounding* ...

...but more practical since *anchoring*
concerns **real physical objects**



Perceptual Anchoring



Example of anchored objects at different timestamps for a 'stirring' scenario



KU Leuven

KU LEUVEN

- Founded in 1425
- 50 000 students, 10 000 staff
- Almost all disciplines represented

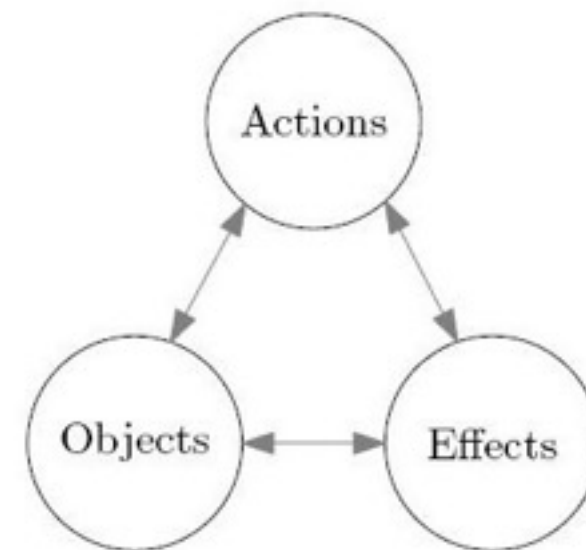


- Lab for Declarative Languages and Artificial Intelligence
- Jesse Davis - ML/NLP
- Luc De Raedt - AI
- Davide Nitti, Laura Antanas - robotics



Relational Affordances

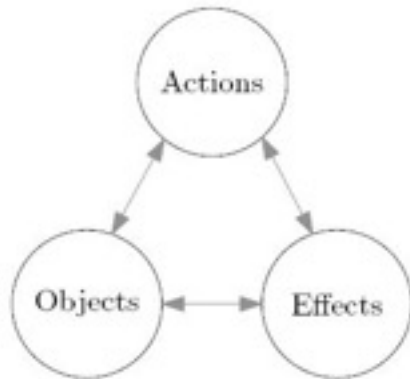
- Object affordance
 - What can one do with a particular object ?
- Relational affordance
 - in a particular context ?
 - with multiple objects and relations among them
- Use of statistical relational learning, probabilistic programming



Inputs	Outputs	Function
(O, A)	E	Effect prediction
(O, E)	A	Action recognition/planning
(A, E)	O	Object recognition/selection

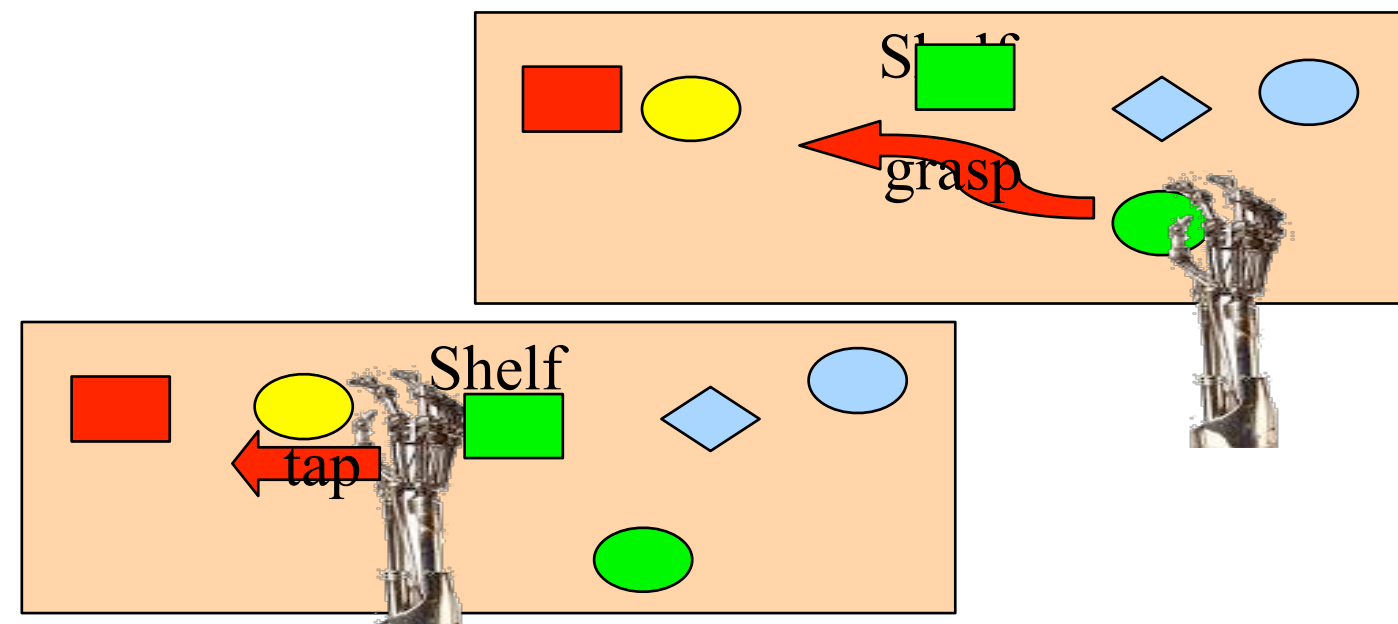
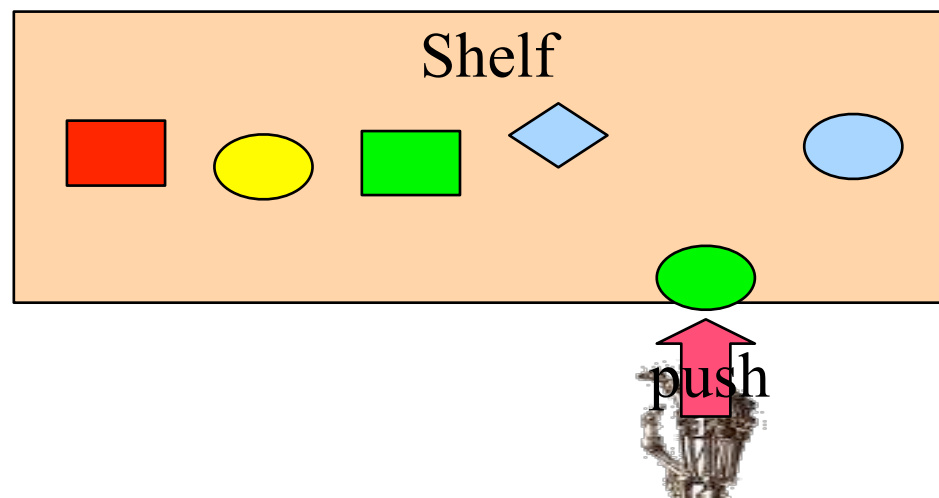
Learning relational affordances

- Learn probabilistic model



Inputs	Outputs	Function
(O, A)	E	Effect prediction
(O, E)	A	Action recognition/planning
(A, E)	O	Object recognition/selection

- Consider multiple objects and their relationship



Learning relational
affordances
between
two objects
(learnt by experience)

Moldovan et al. ICRA 12, 13, 14, PhD 15

Reground: Winograd's setting in the real world



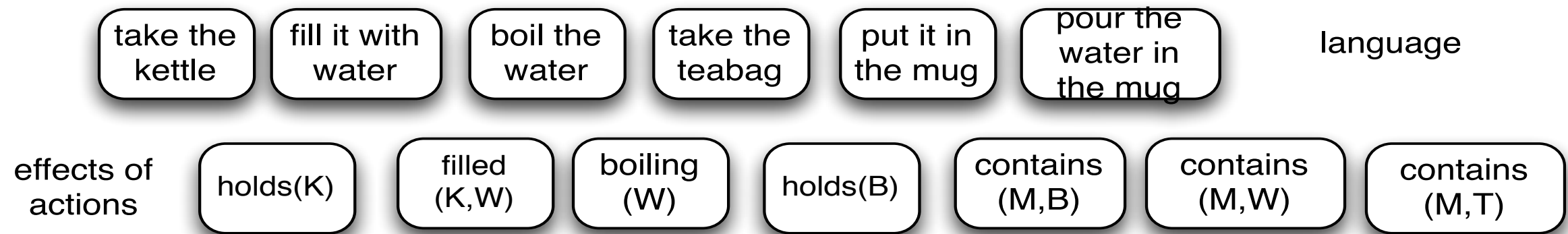
Bring me the tea pot and the sugar

From Symbol to Affordance Grounding

- Three assumptions:
 - **multi-modal input** (perception and language);
anchoring and symbol grounding
 - take into account the **context & environment** —
multiple objects (multiple symbols & referents)
and their relationships
 - build on a notion of **affordance** from robotics
(captures relevant relationships)

Example scenario

Making tea



perception

Tea making scenario

Targeted breakthrough

From “symbol grounding” to "affordance" grounding

agents can adapt to new environment and interpret possibly unimodal input to achieve goals

Three aspects :

anchoring problem in perception (Orebrö University)

language grounding (Koc University)

relational representations and learning (KULeuven)

Expected outputs

1. Novel techniques that perform symbol grounding by learning relational affordances.
2. New insights into symbol grounding, relational affordances, and developmental language learning.
3. Demonstration that relational grounding significantly improves the percentage of successfully completed tasks in both a simulated environment and a real robotic setup about a household environment.
4. Publicly available data from the robotic and simulated environment and code for our algorithms.