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Context in Cognitive Hierarchies

Bernhard Hengst
Maurice Pagnucco
David Rajaratnam
Claude Sammut
Michael Thielscher

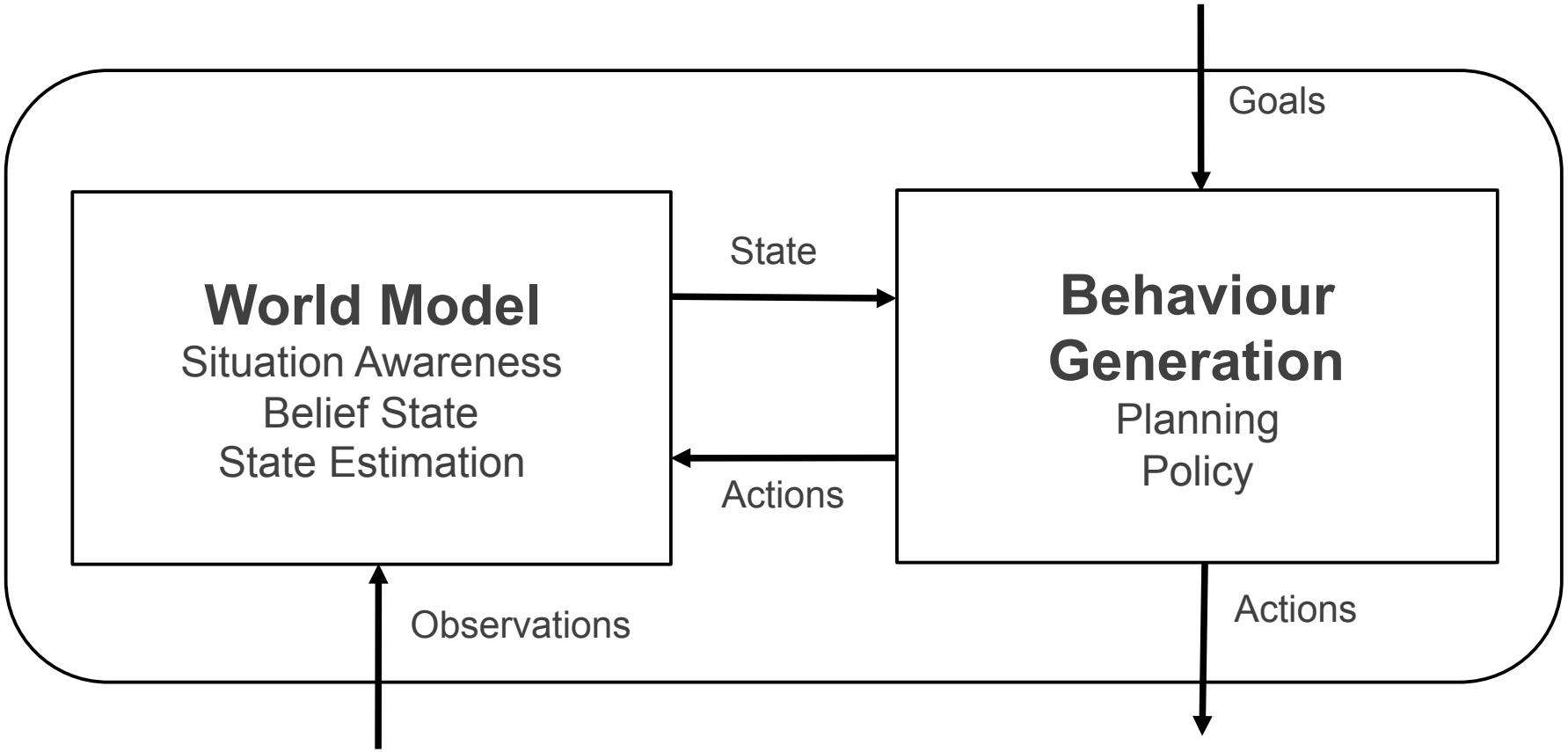
Bicentennial Man (film) 1999

Outline

- Cognitive Hierarchy
- Context
- Next steps

A Node

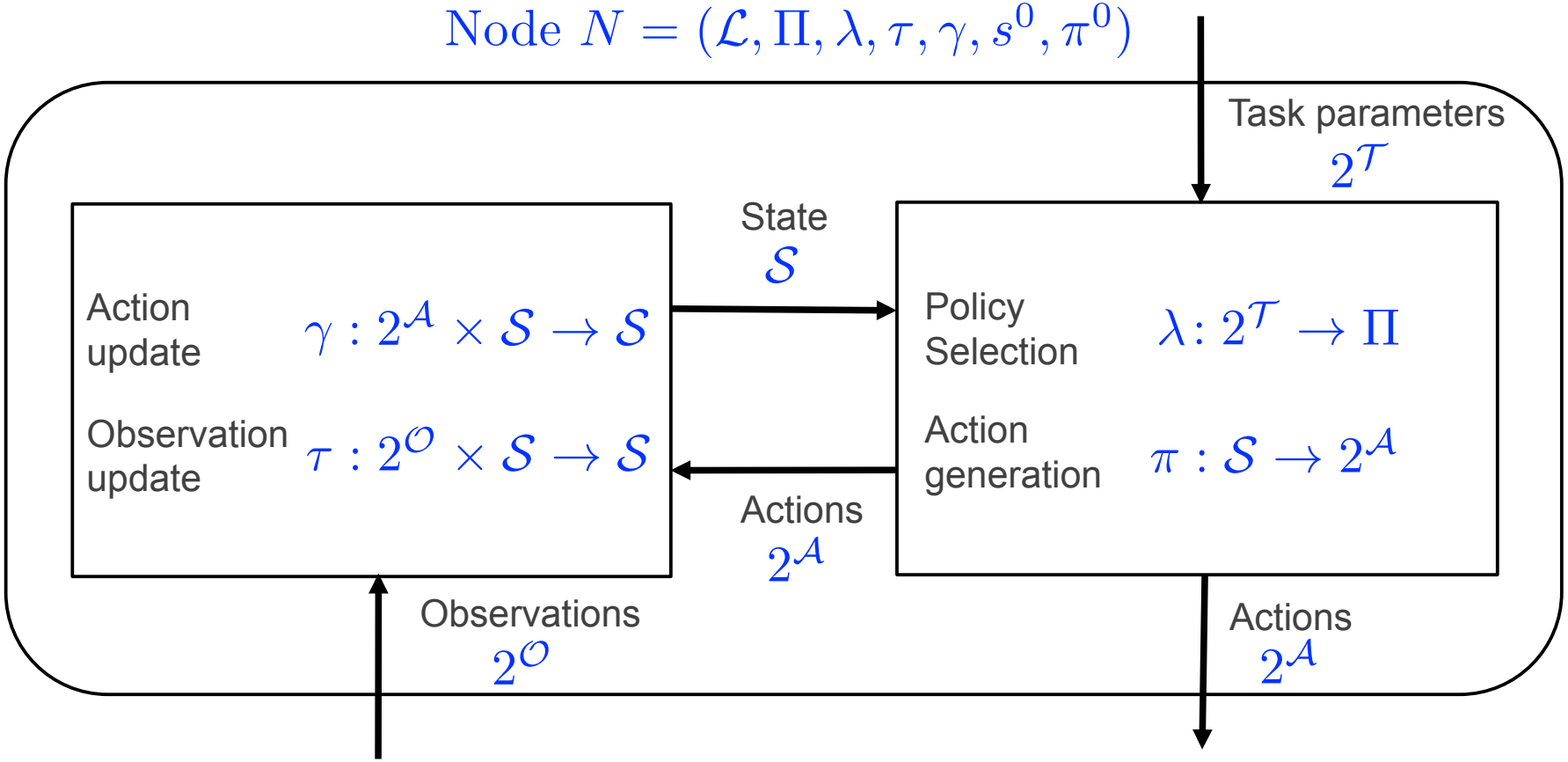
Sense-Act



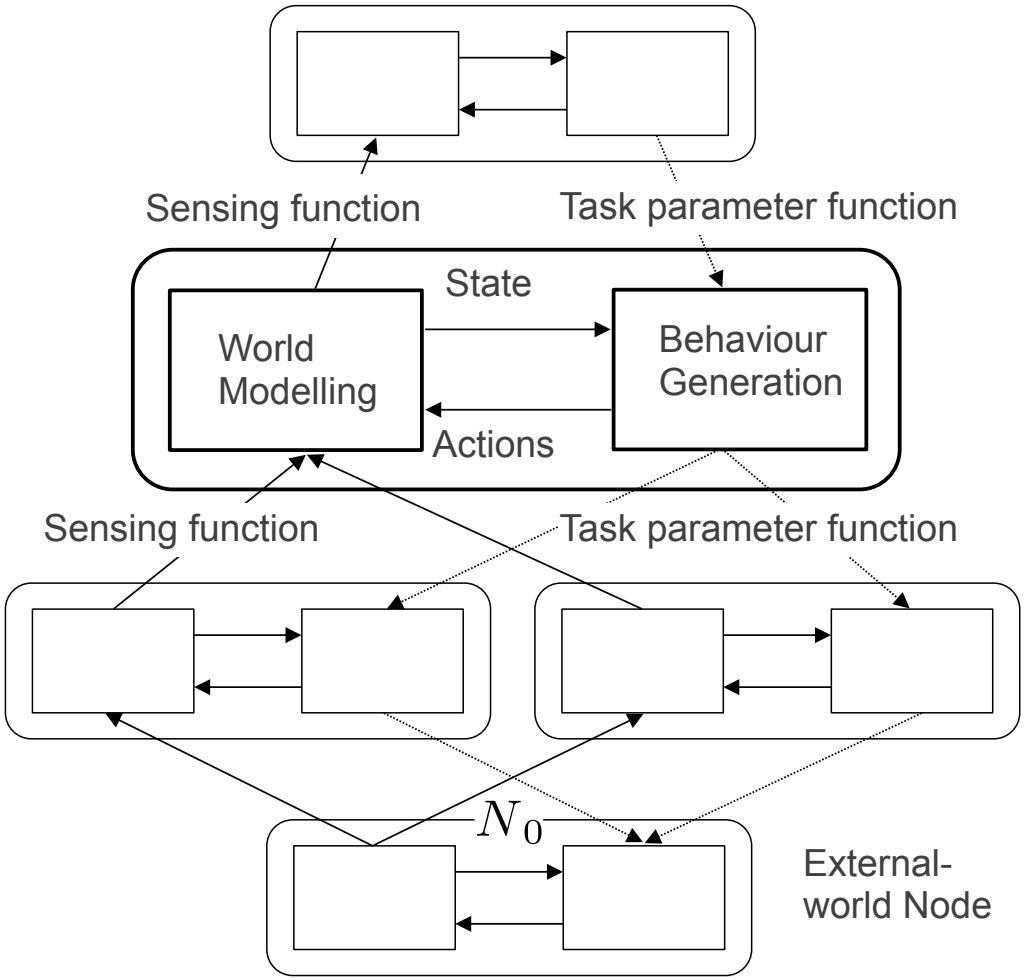
Formalization of a Node

$$\text{Language } \mathcal{L} = (\mathcal{S}, \mathcal{A}, \mathcal{T}, \mathcal{O})$$

$$\text{Node } N = (\mathcal{L}, \Pi, \lambda, \tau, \gamma, s^0, \pi^0)$$



Formalization of Cognitive Hierarchy

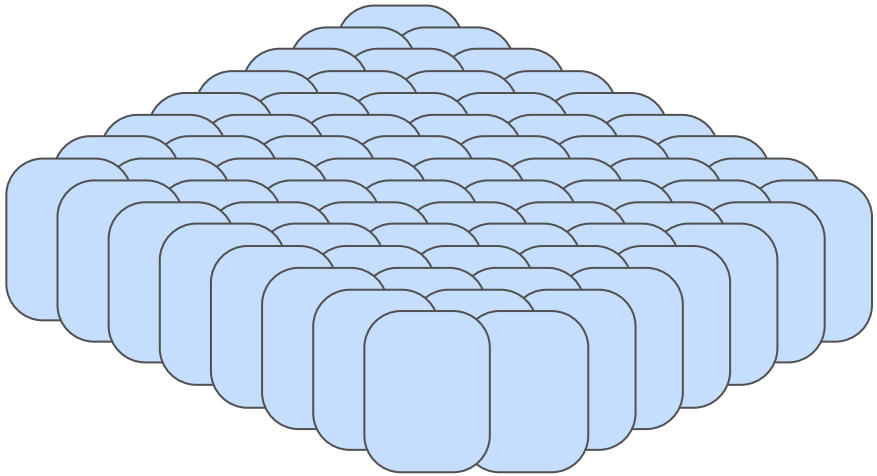


Proceedings of the Twenty-Fifth International Joint Conference on Artificial Intelligence (IJCAI-16)

A Framework for Integrating Symbolic and Sub-symbolic Representations

Keith Clark Imperial College
Bernhard Hengst University of NSW
Maurice Pagnucco University of NSW
David Rajaratnam University of NSW
Peter Robinson University of Queensland
Claude Sammut University of NSW
Michael Thielscher University of NSW

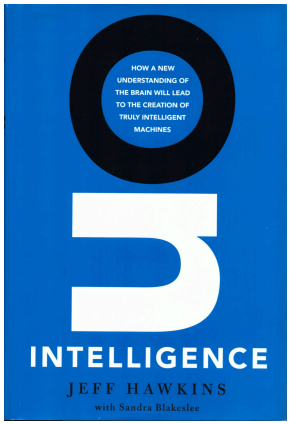
Architecture Inspired by Neurophysiology



Uniform columnar organization

Vernon Mountcastle *Brain* 1997

On Intelligence



Jeff Hawkins
2004

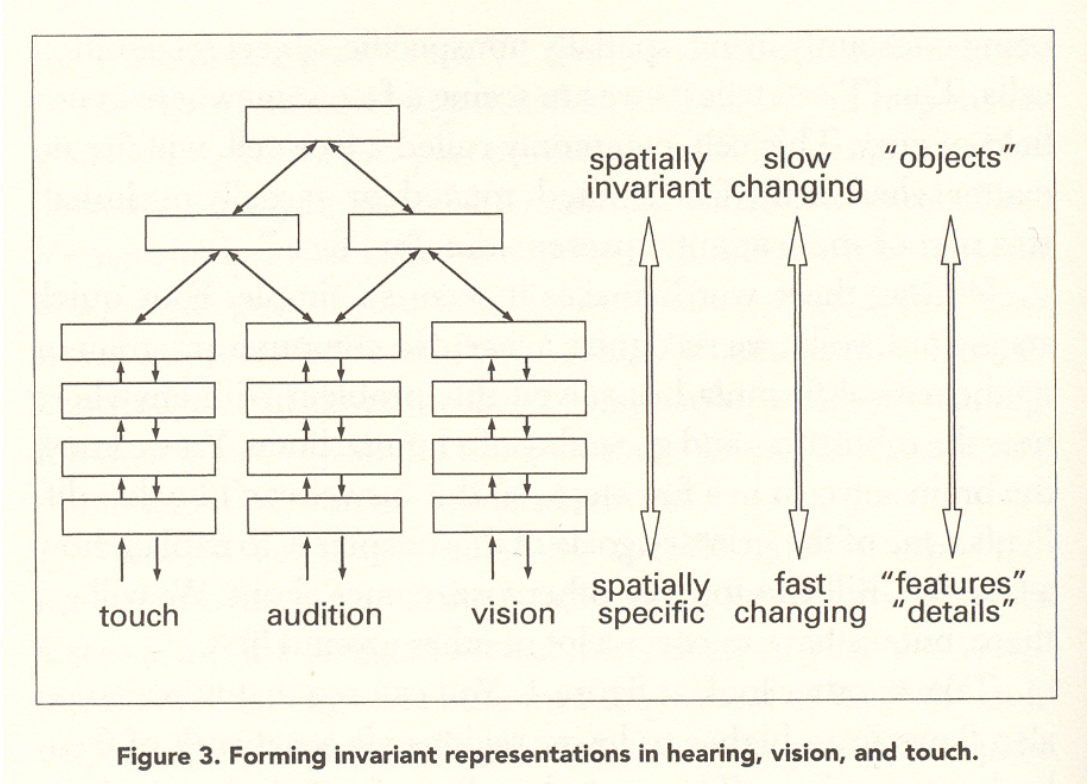
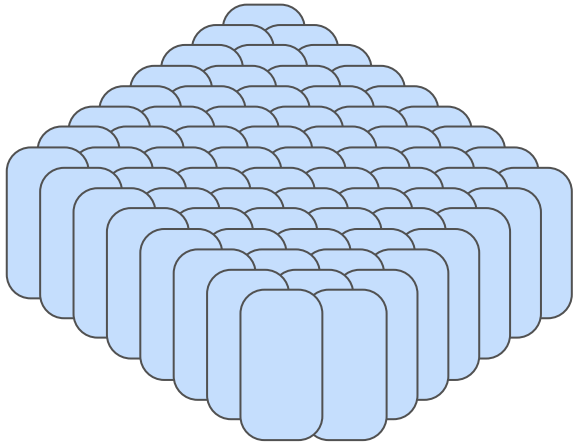
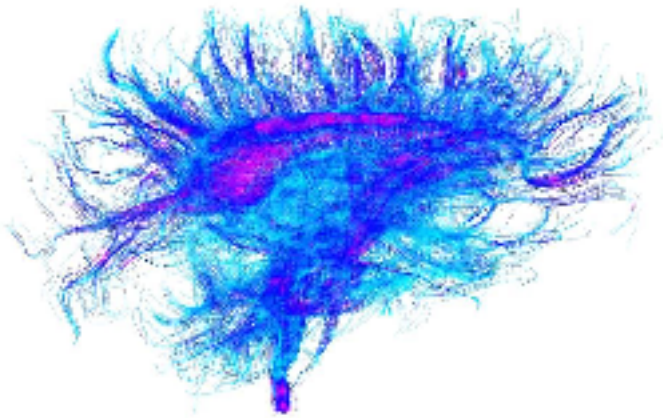
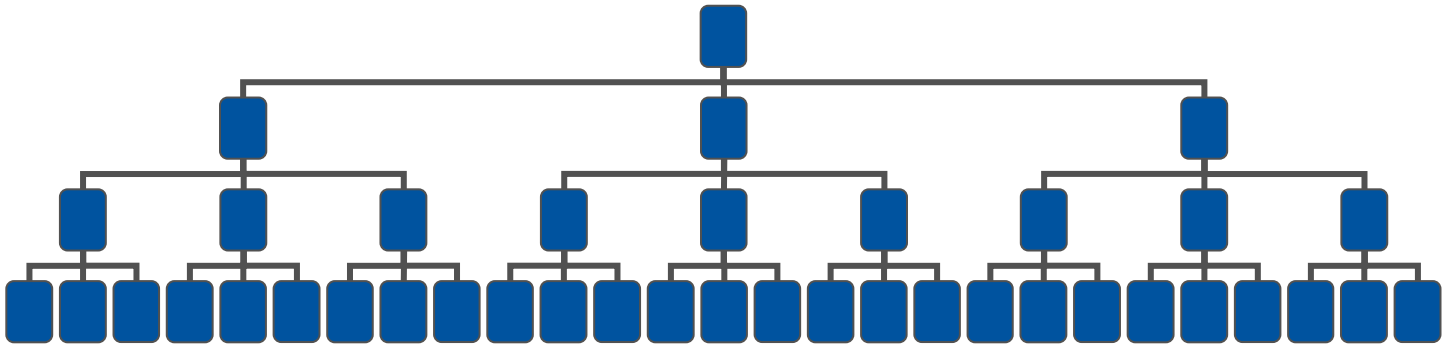


Figure 3. Forming invariant representations in hearing, vision, and touch.

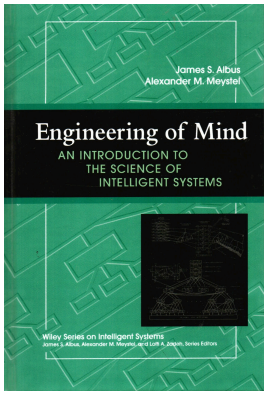
Architecture Inspired by Neurophysiology



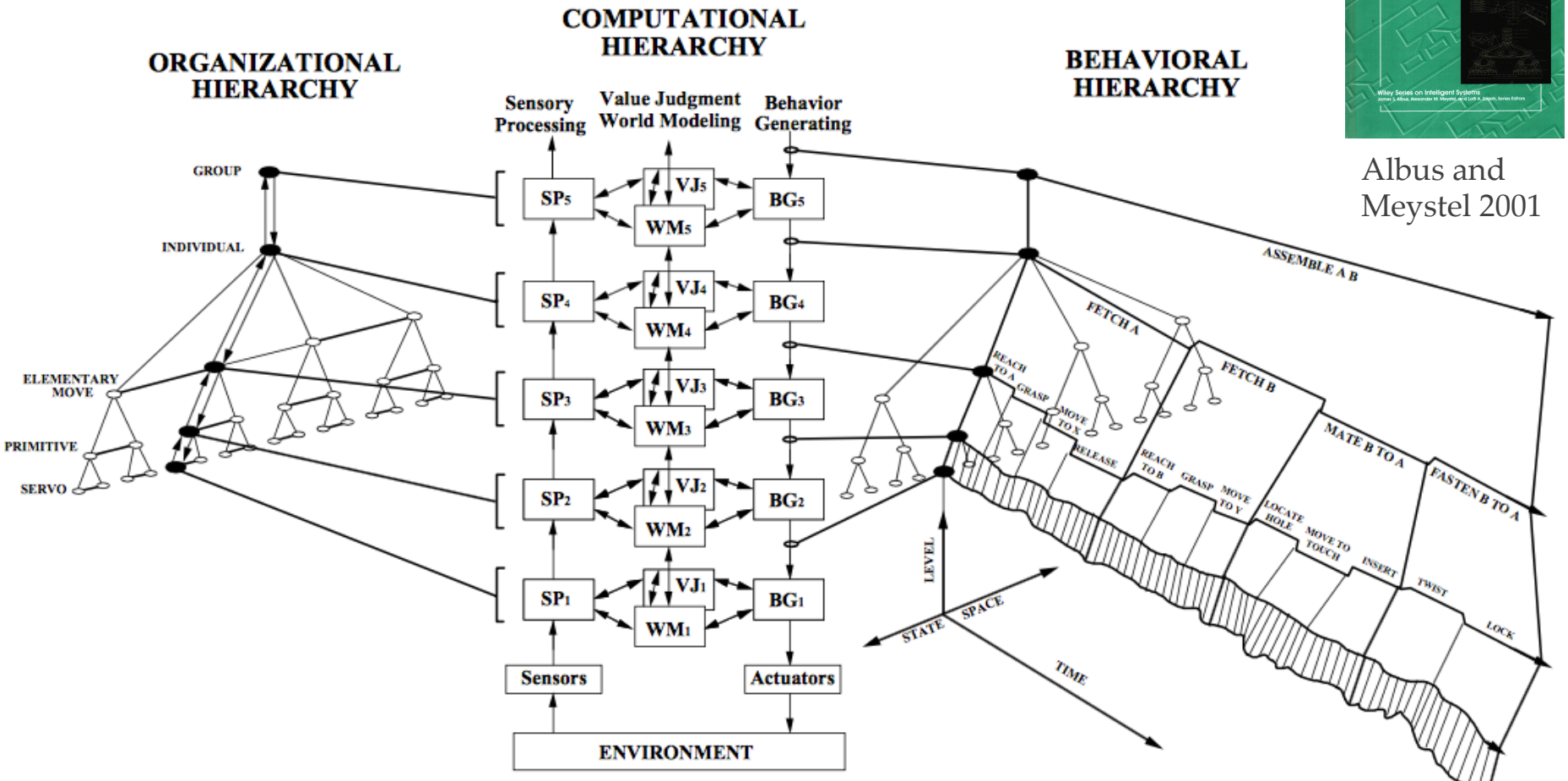




Engineering of Mind



Albus and Meystel 2001



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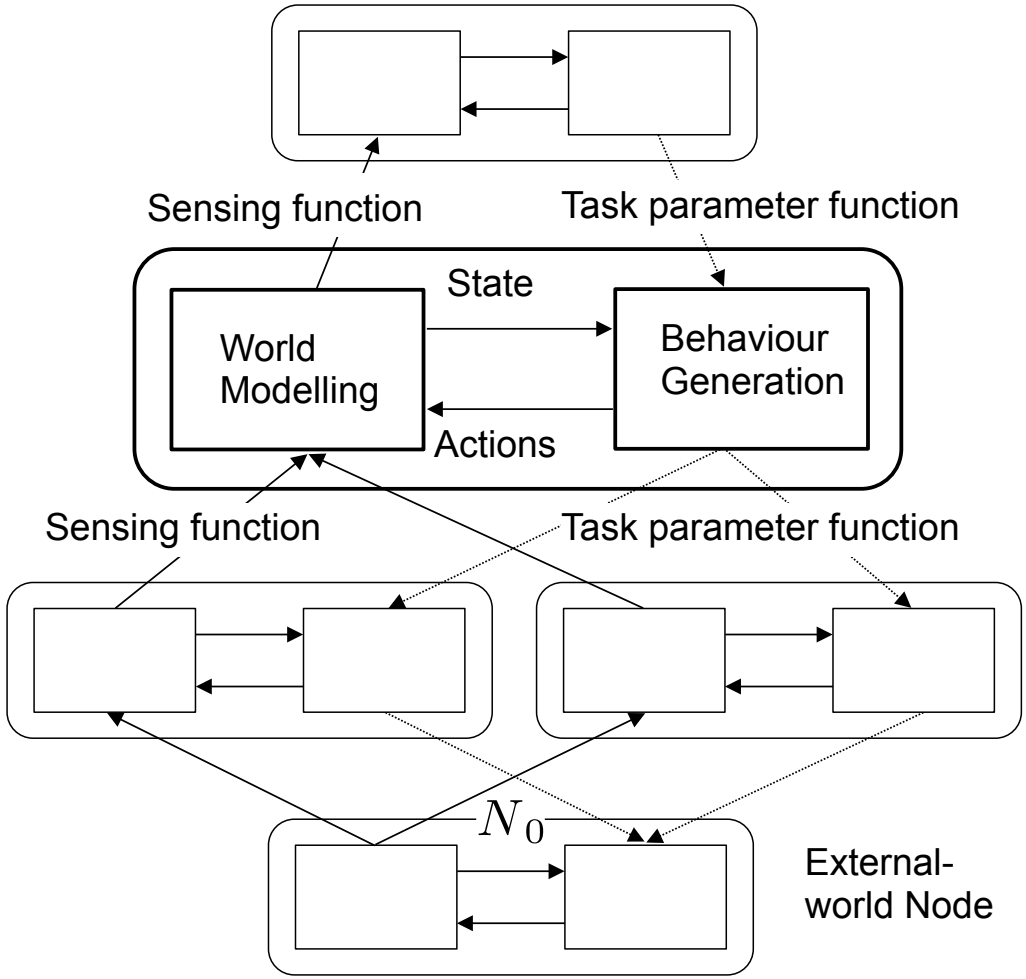
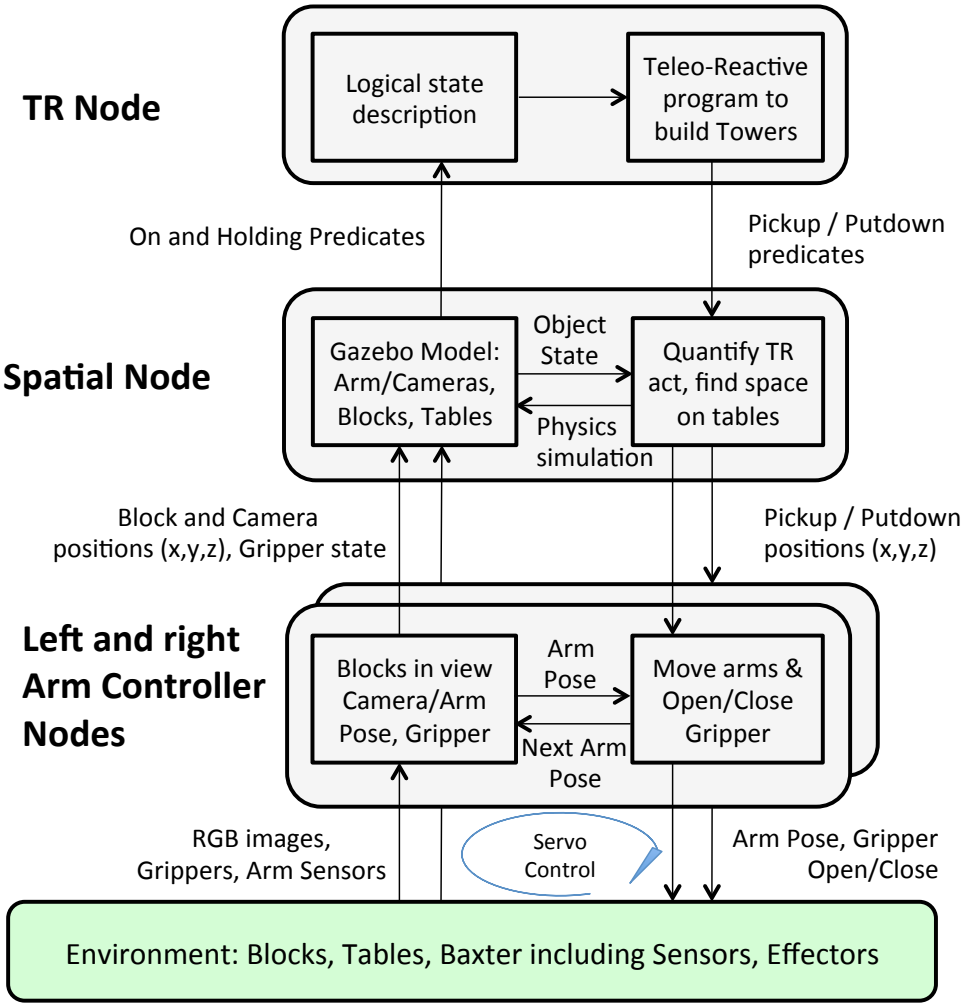
Cognitive Hierarchy



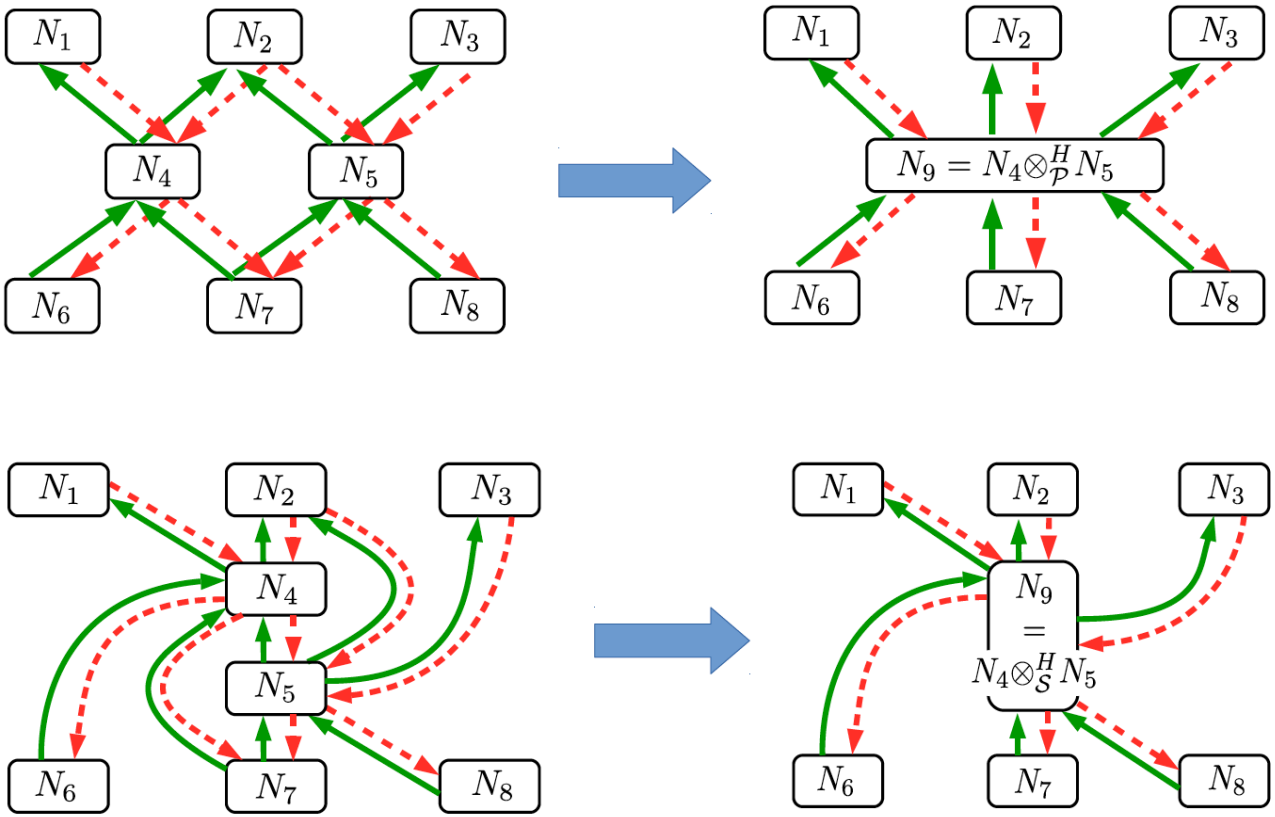
Baxter

Instantiated Cognitive Hierarchy

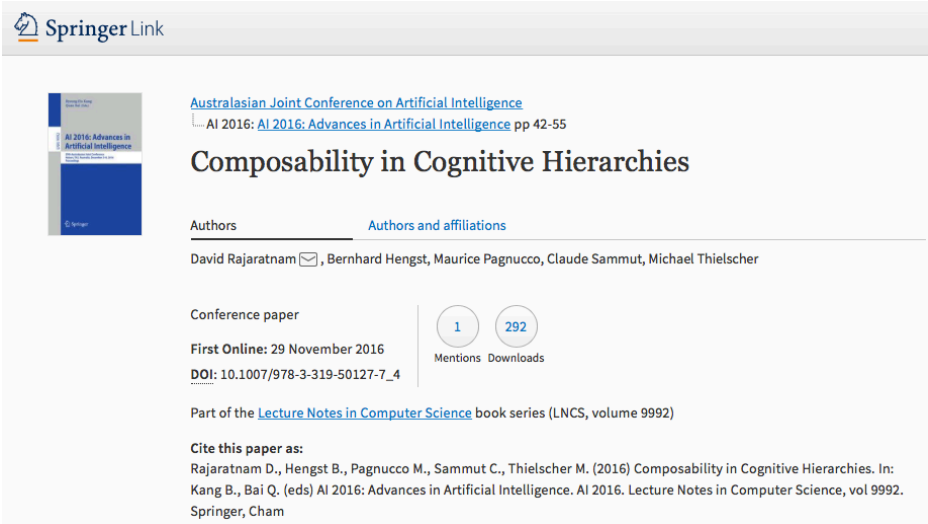


Instantiation using Baxter

Composability in Cognitive Hierarchies



Composability in Cognitive Hierarchies



Springer Link

Australasian Joint Conference on Artificial Intelligence
AI 2016: AI 2016: Advances in Artificial Intelligence pp 42-55

Composability in Cognitive Hierarchies

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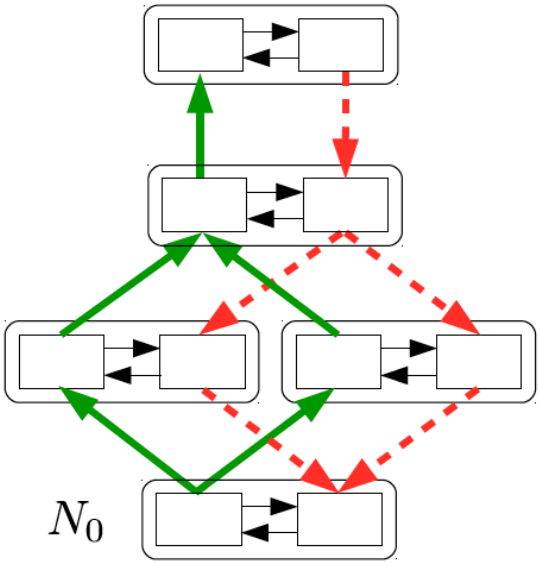

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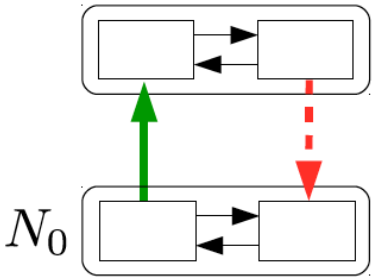

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Context

Tipple Tower Architecture

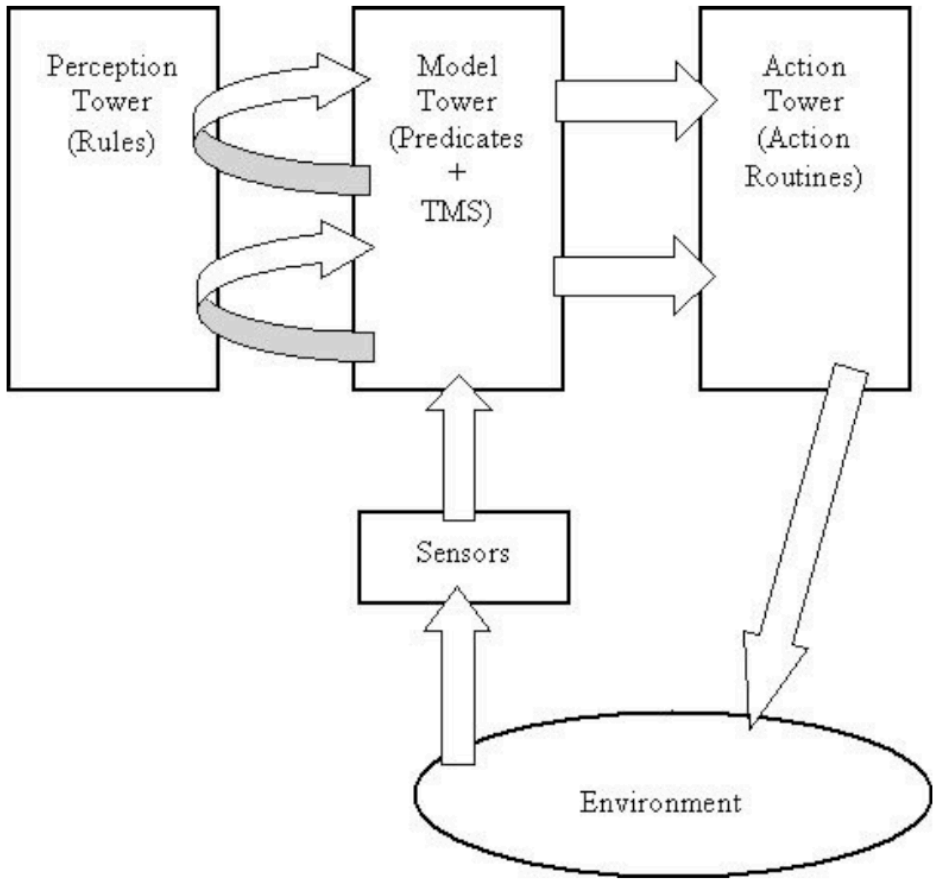


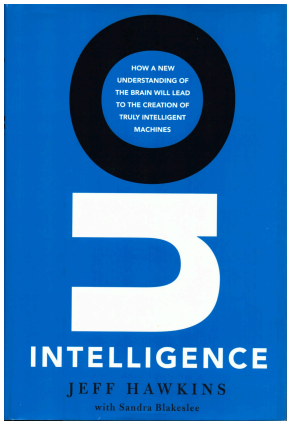
Figure 1: A Triple-Tower Architecture

Nils Nilsson
2001

Context

“I ate a pear” and “I have eight pears”

On Intelligence



Jeff Hawkins
2004

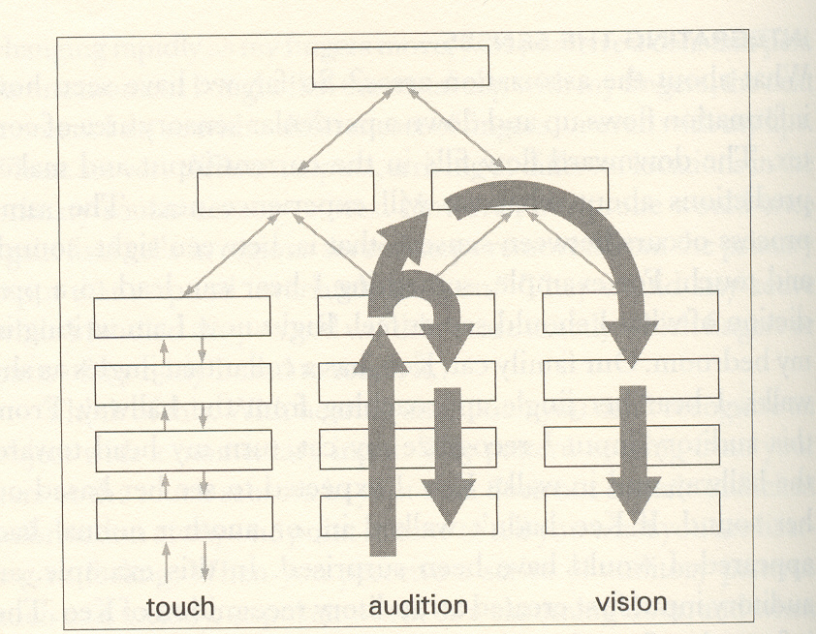
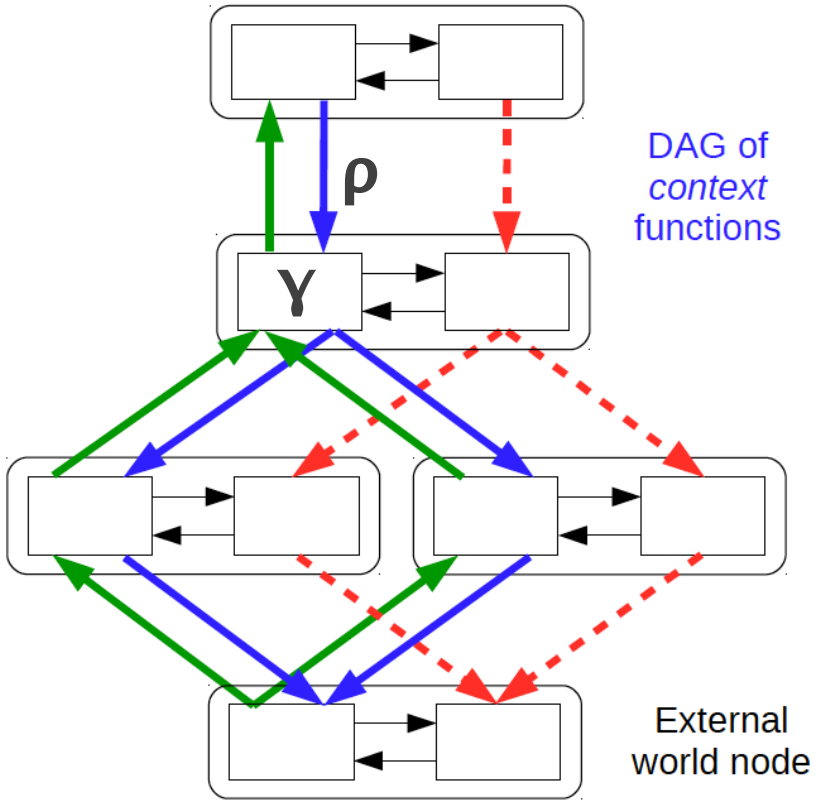


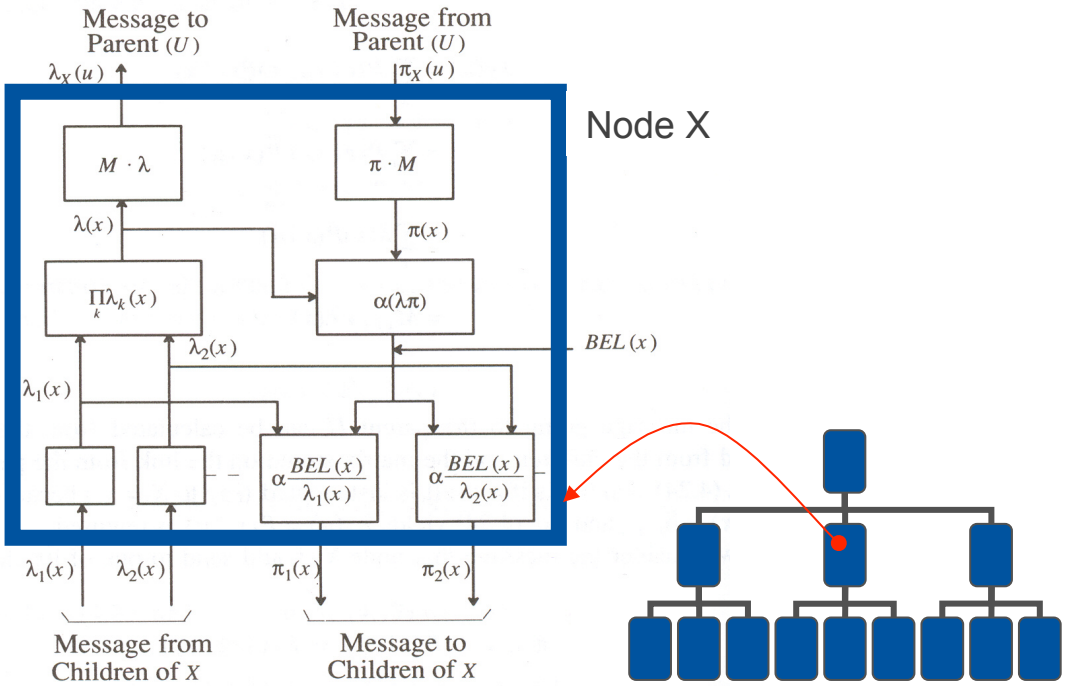
Figure 4. Information flows up and down sensory hierarchies to form predictions and create a unified sensory experience.

Formalising Context



Bayesian Reasoning

Probabilistic Reasoning in Intelligent Systems: Judea Pearl 1988



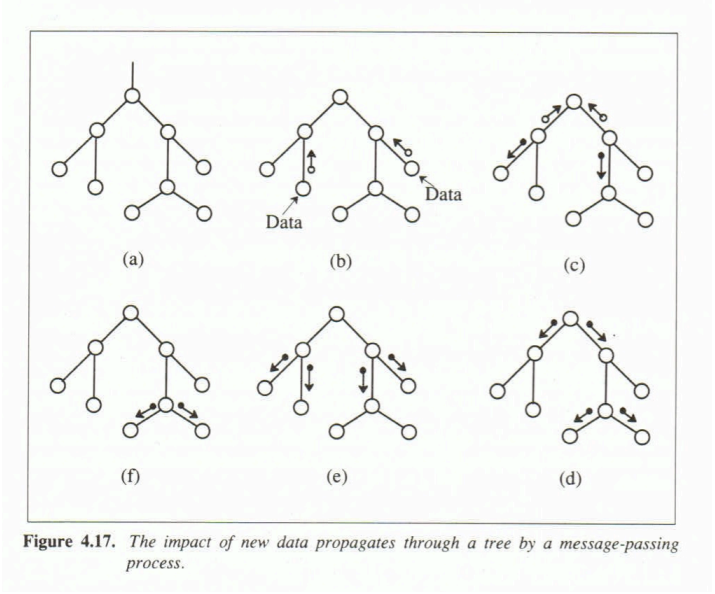


Figure 4.17. *The impact of new data propagates through a tree by a message-passing process.*

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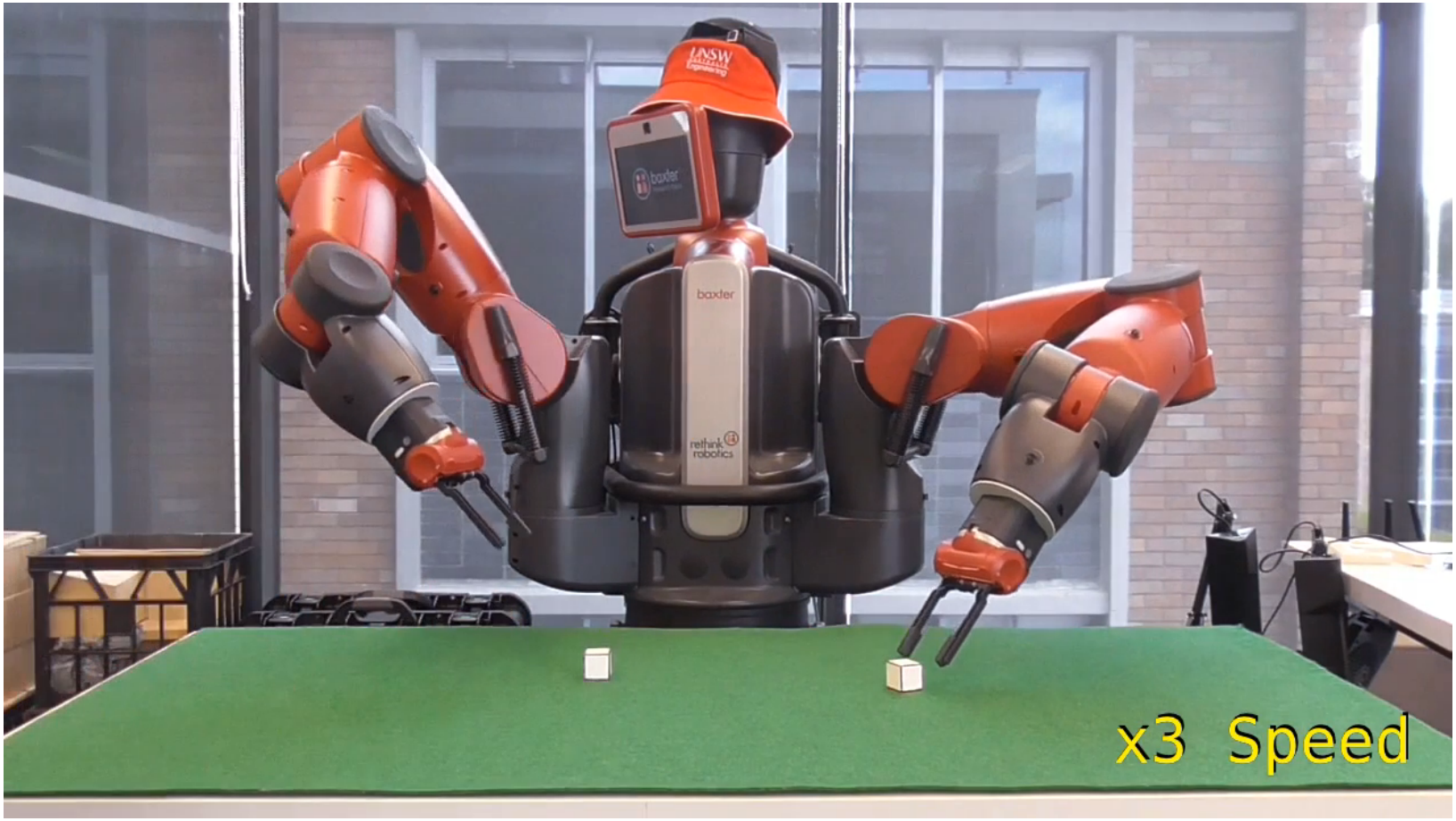
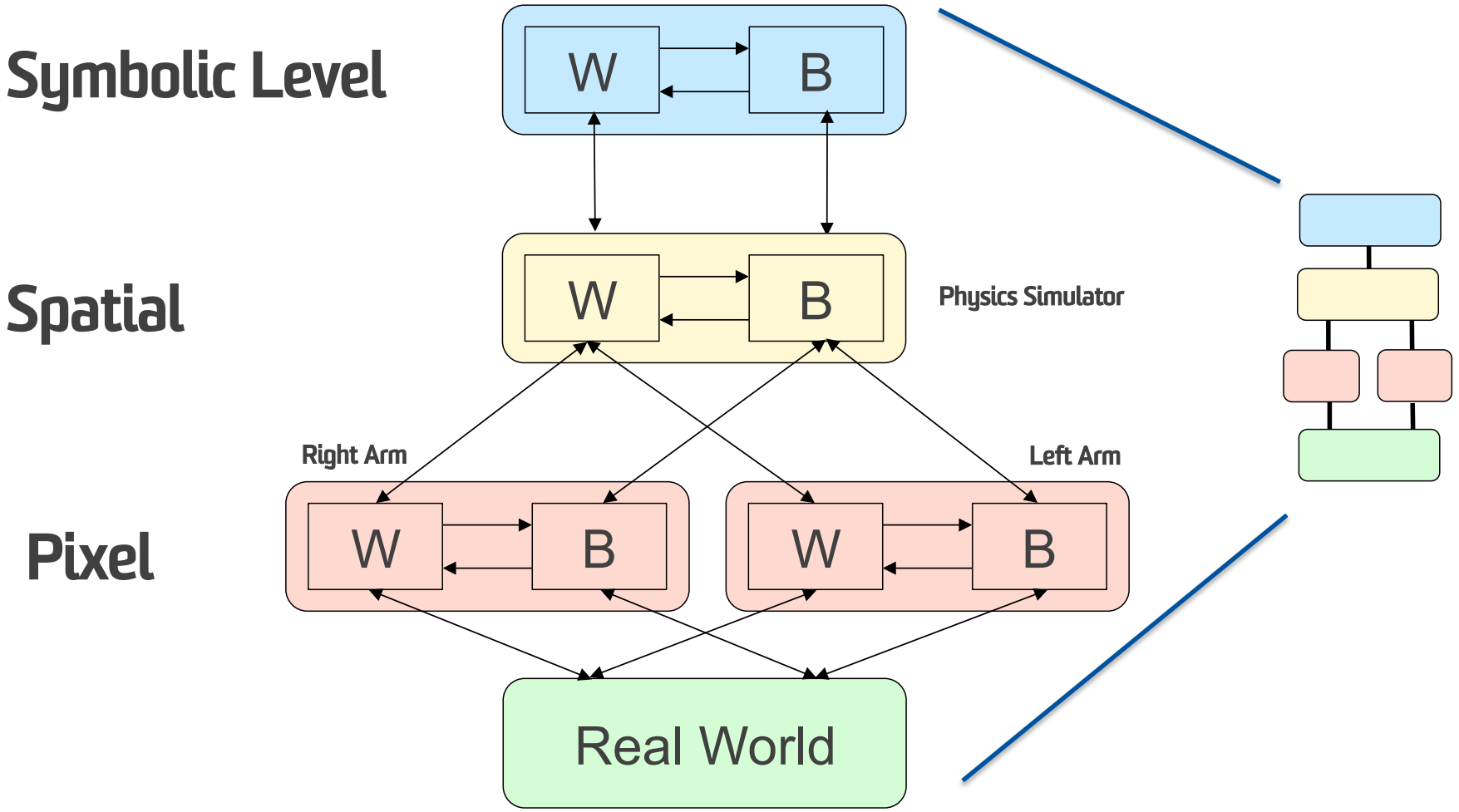
3D Object Recognition and Manipulation

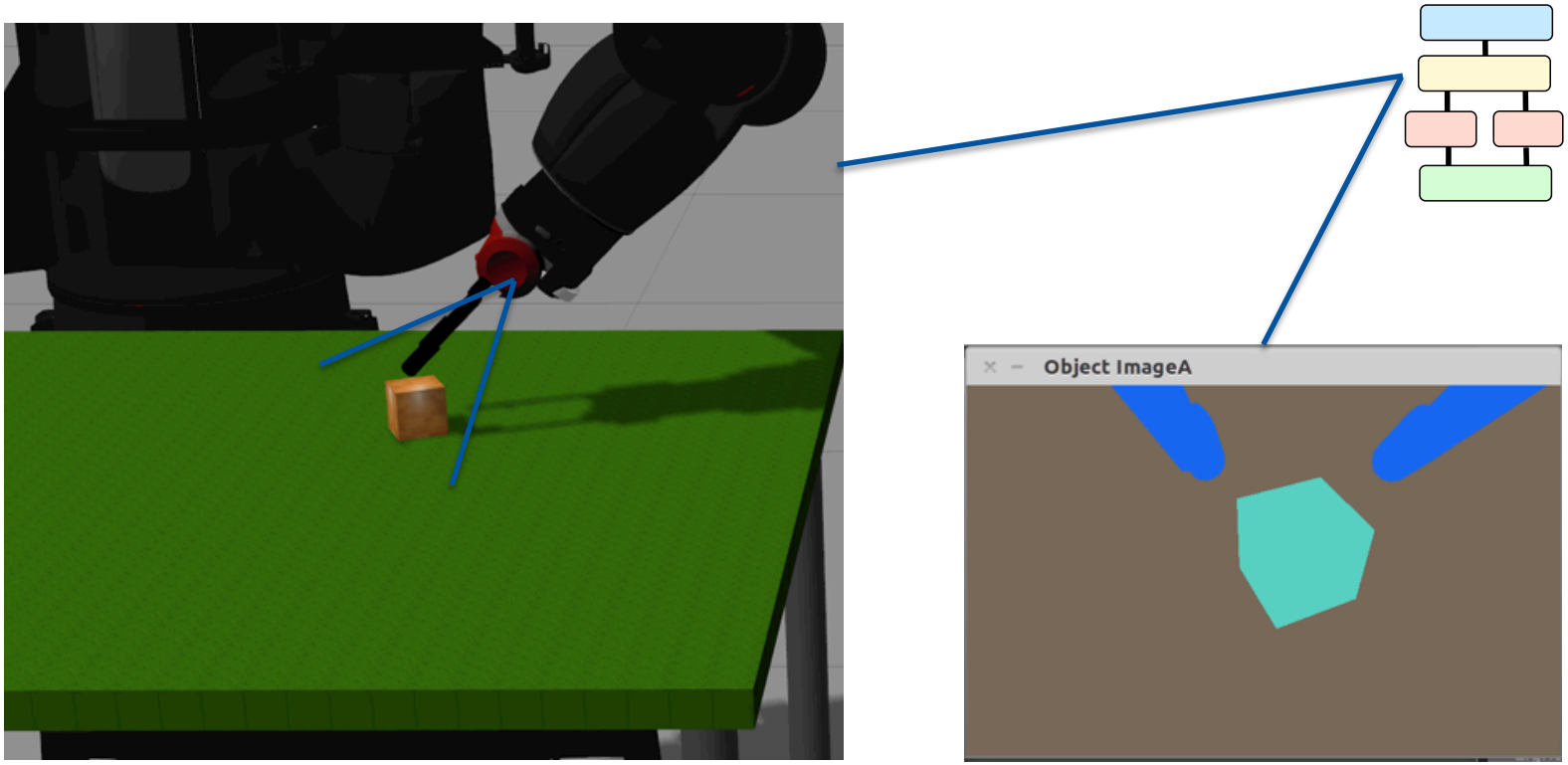


Situation Awareness

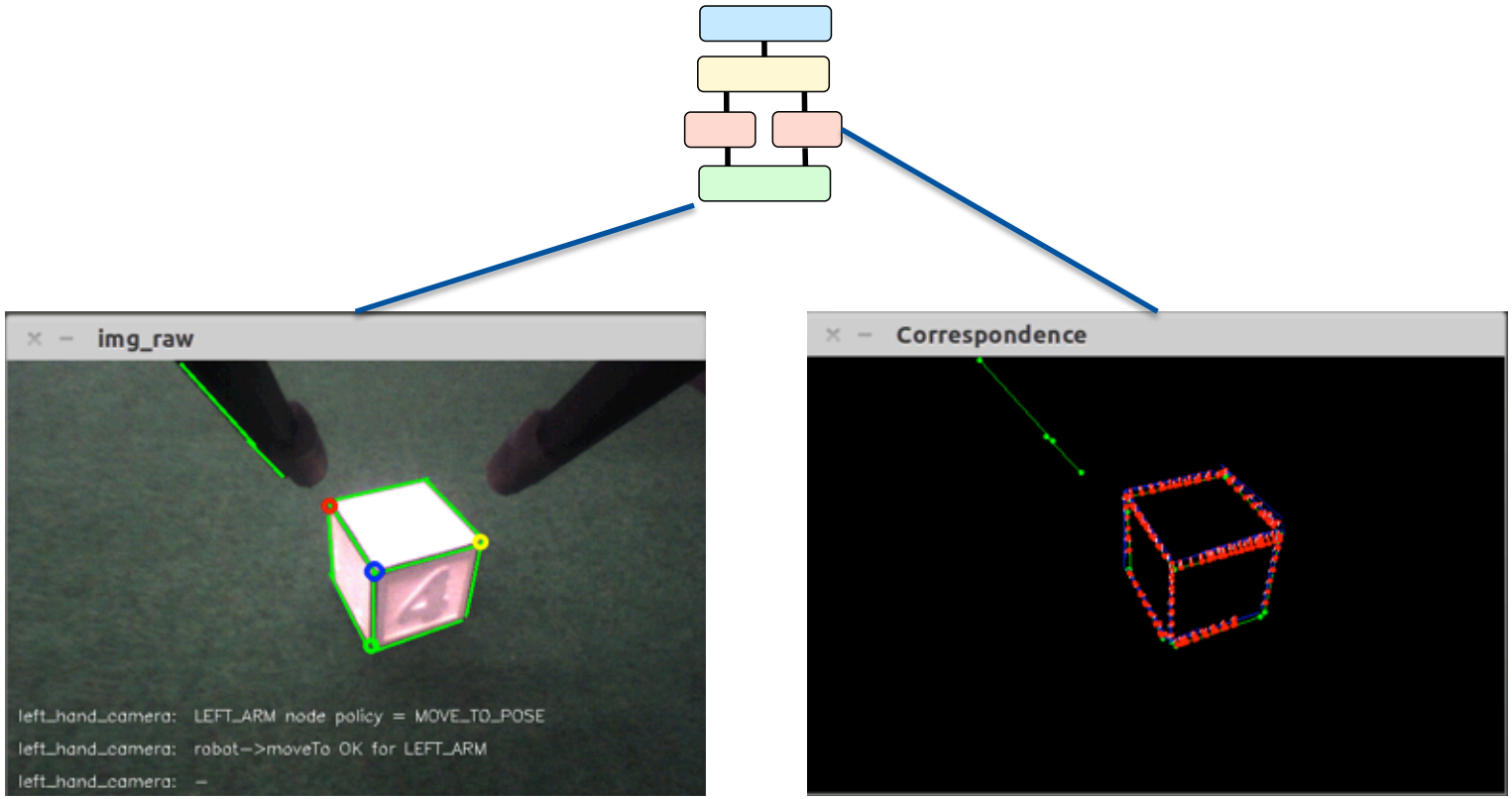
Schematic of Baxter Instantiation



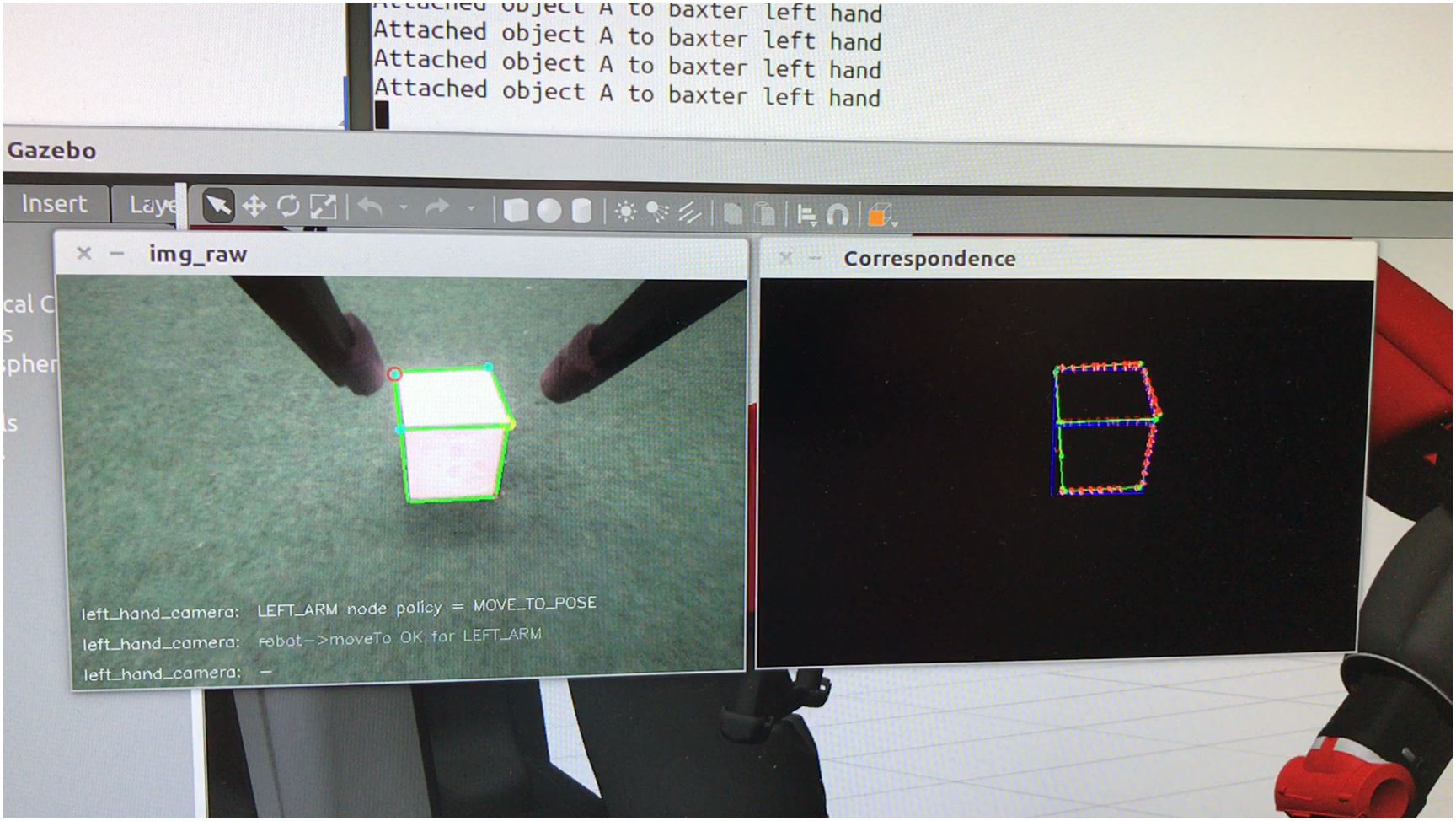
Object Aware Virtual Depth Camera



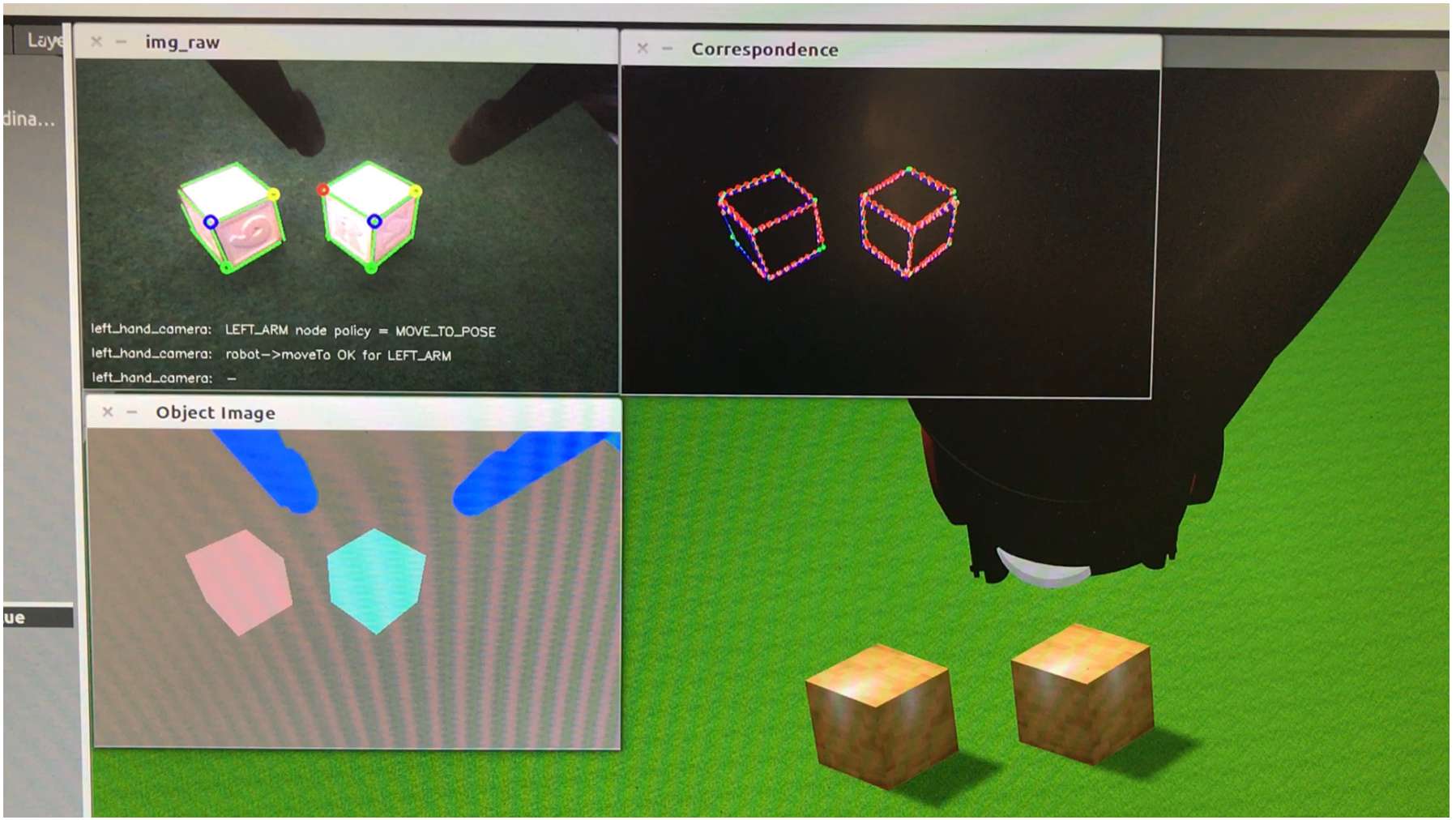
Contextual use of Virtual Depth Camera



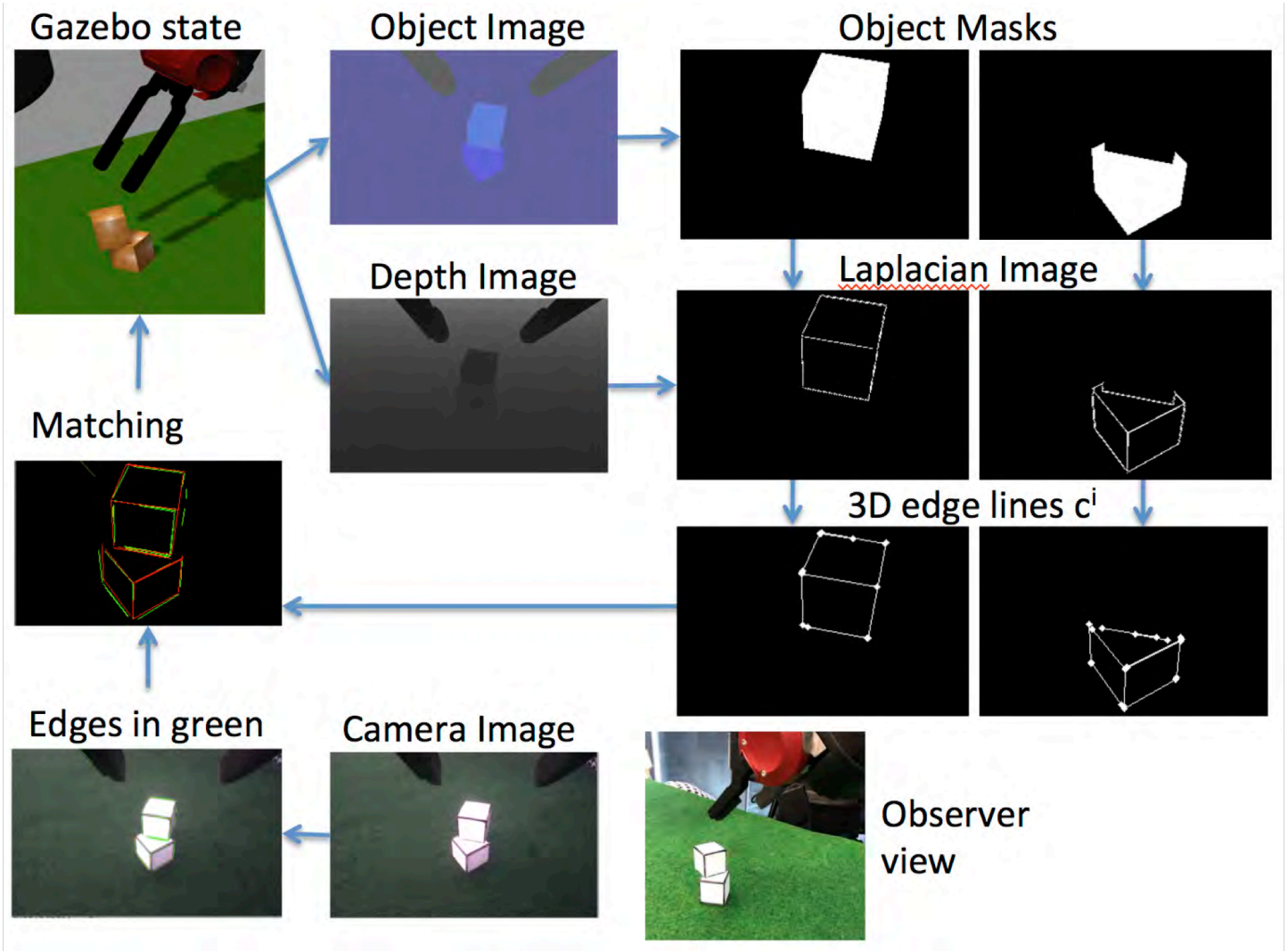
2D Camera Cube Tracking with 3D Context



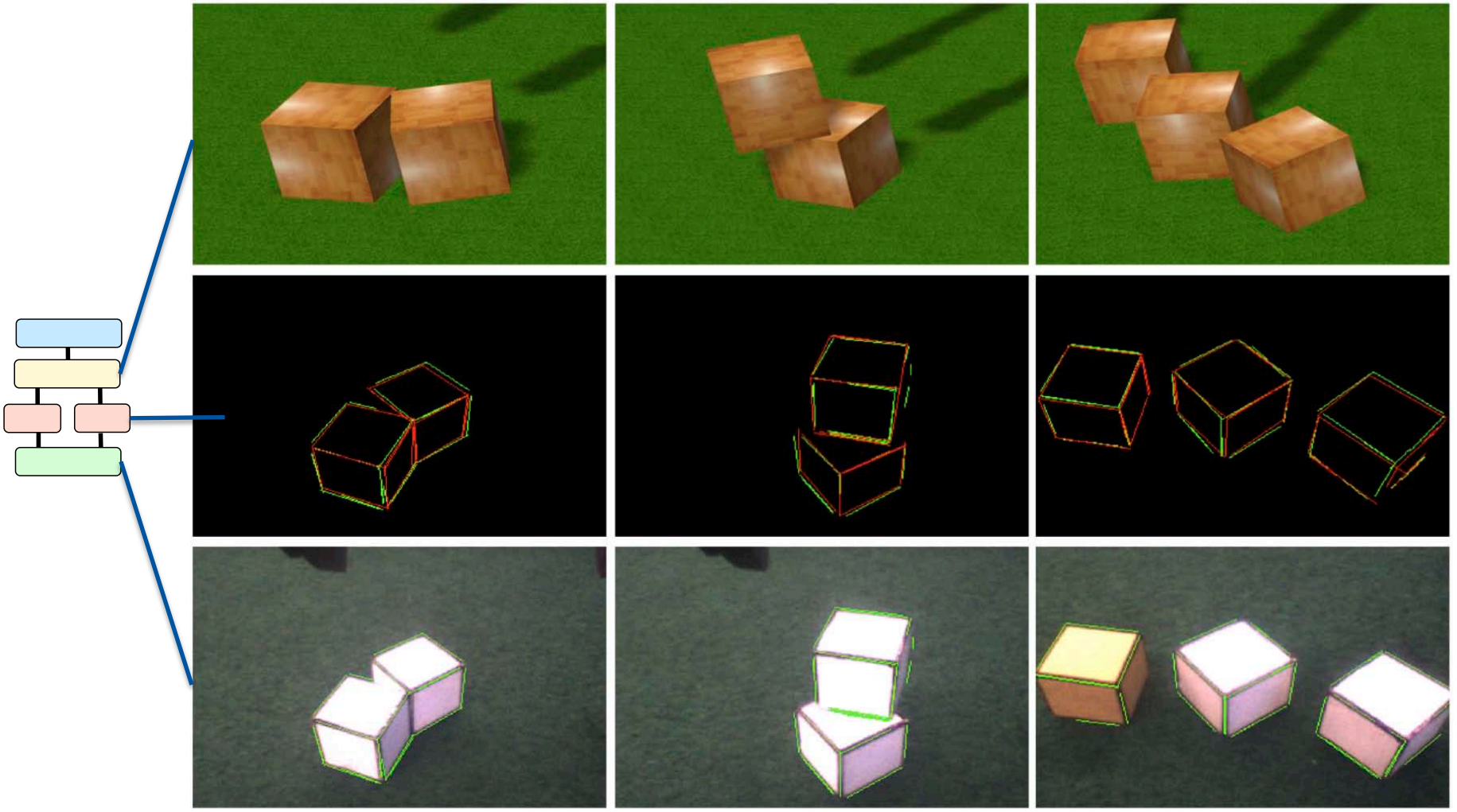
2D Camera Cube Tracking with 3D Context



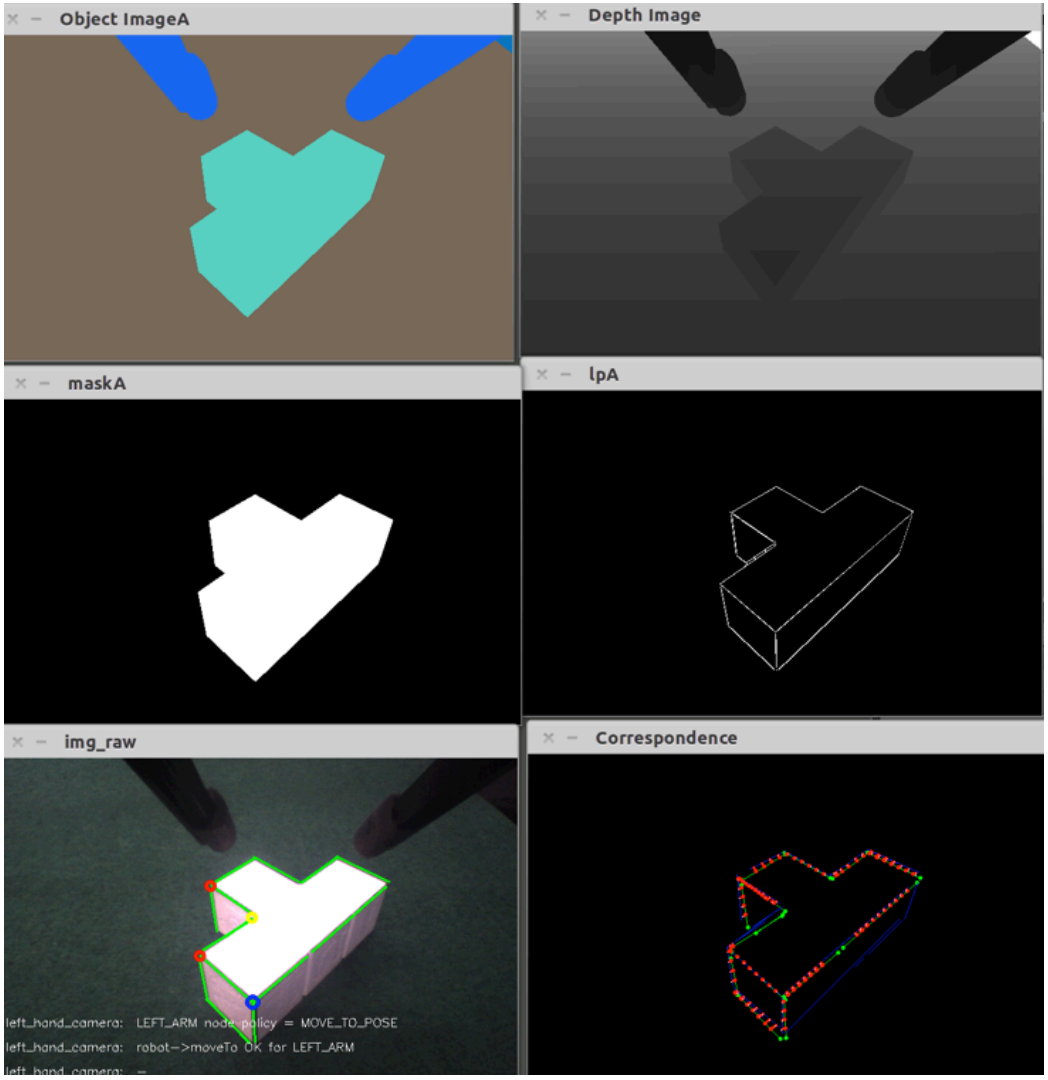
Tracking using Spatial Context

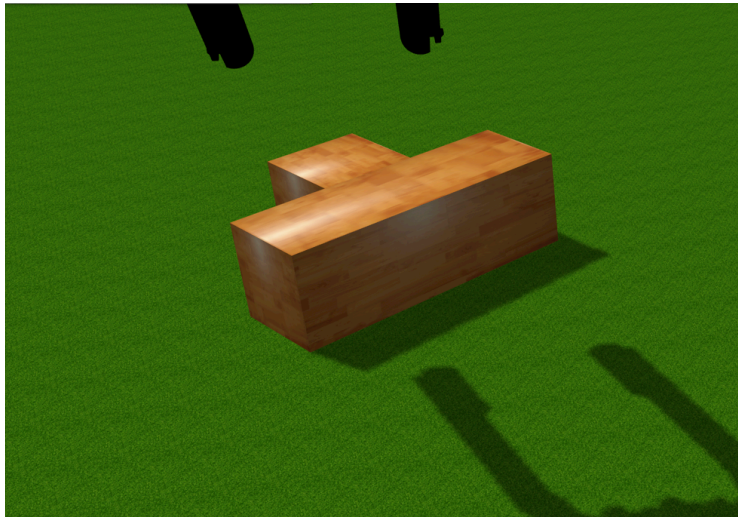


Multiple Object Tracking

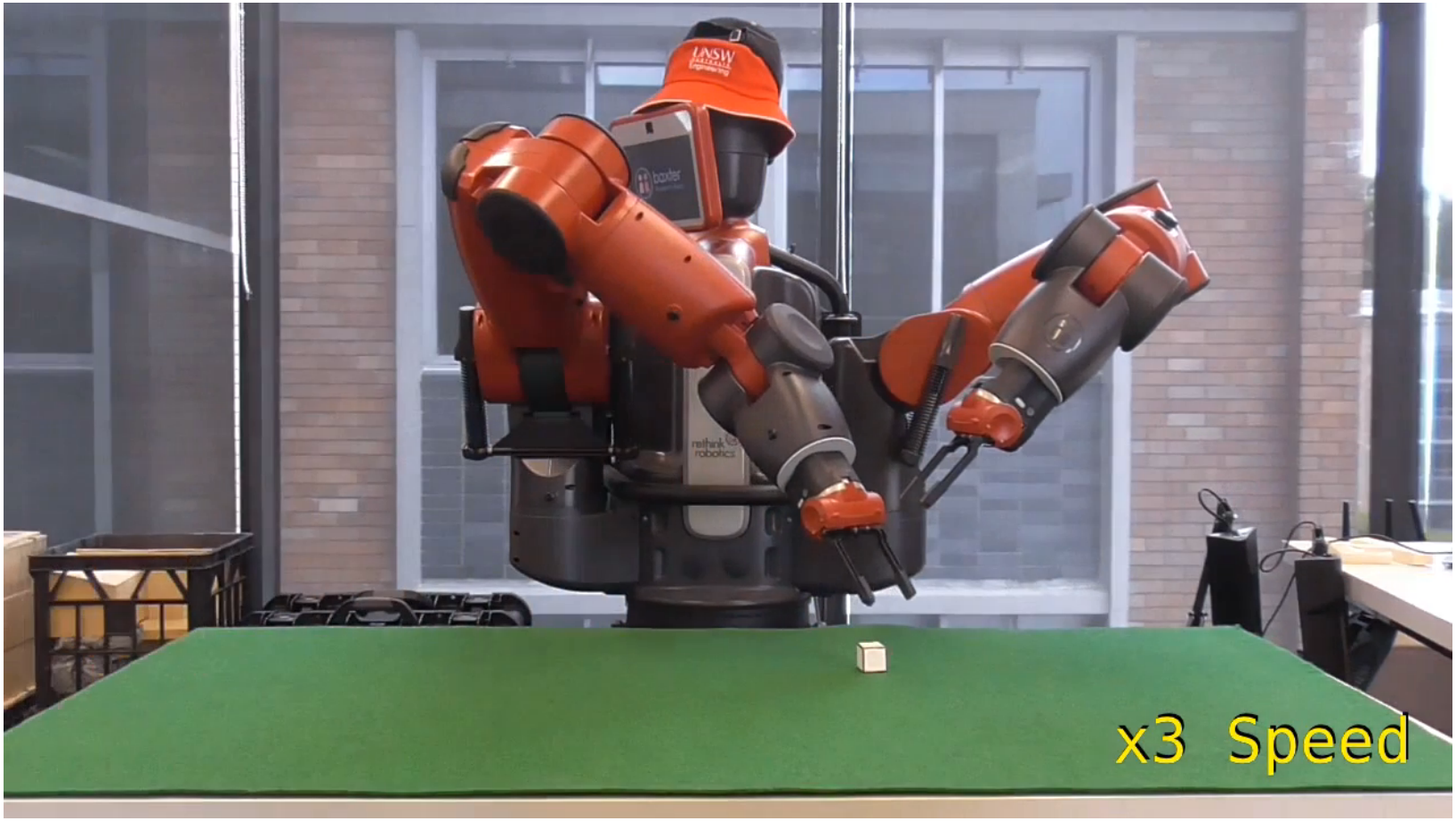


Other Objects eg T-Block



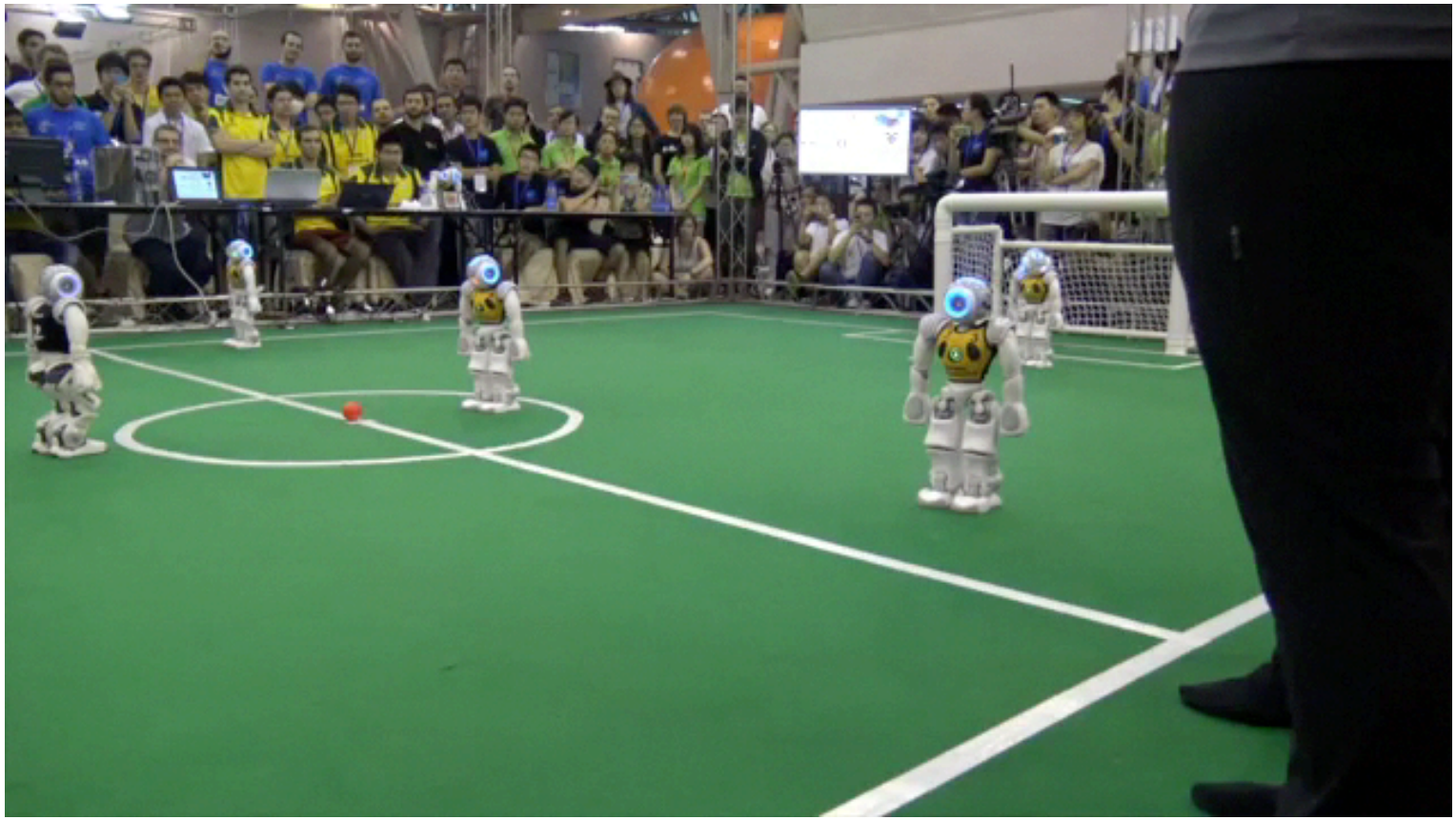


3D Object Recognition and Manipulation



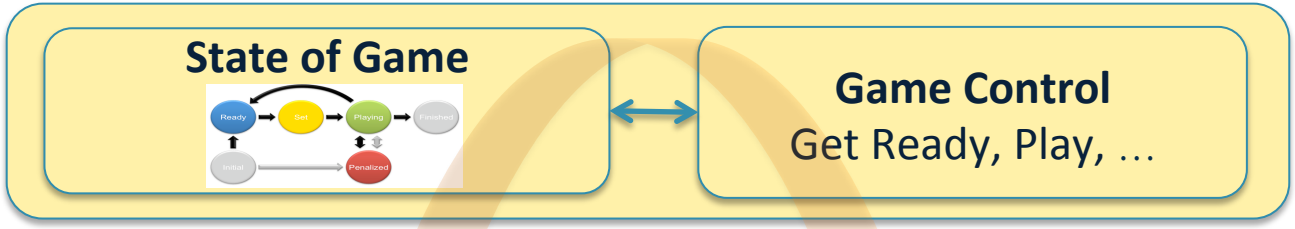
Next Steps

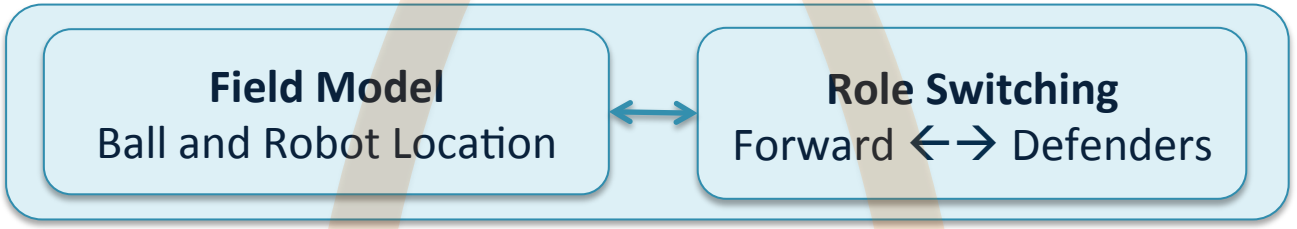
Robocup Standard Platform League

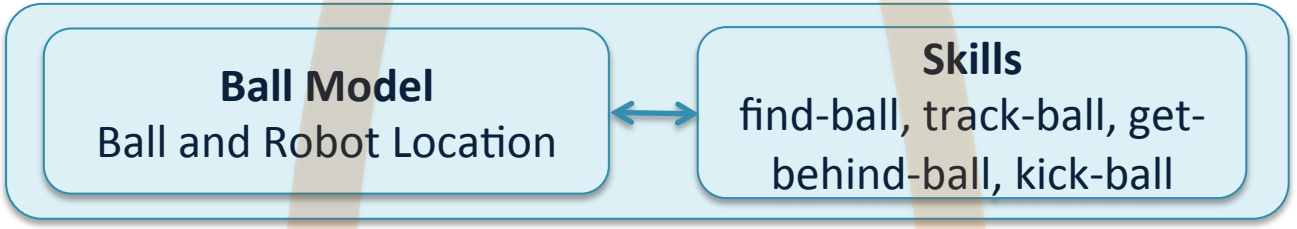


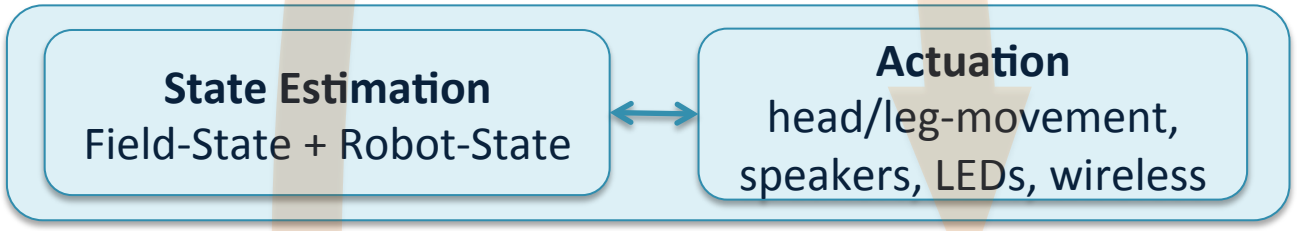
UNSW vs Uni. Bremen RoboCup 2015 SPL Final

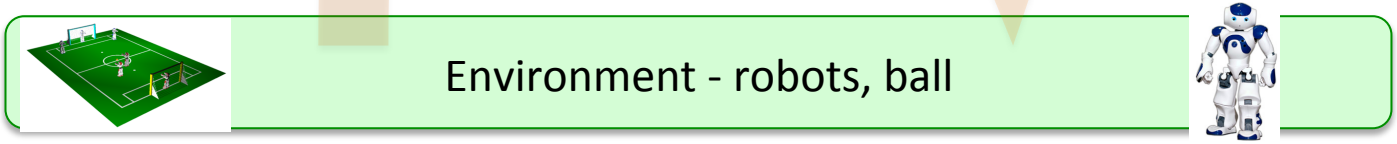
RoboCup Cognitive Hierarchy



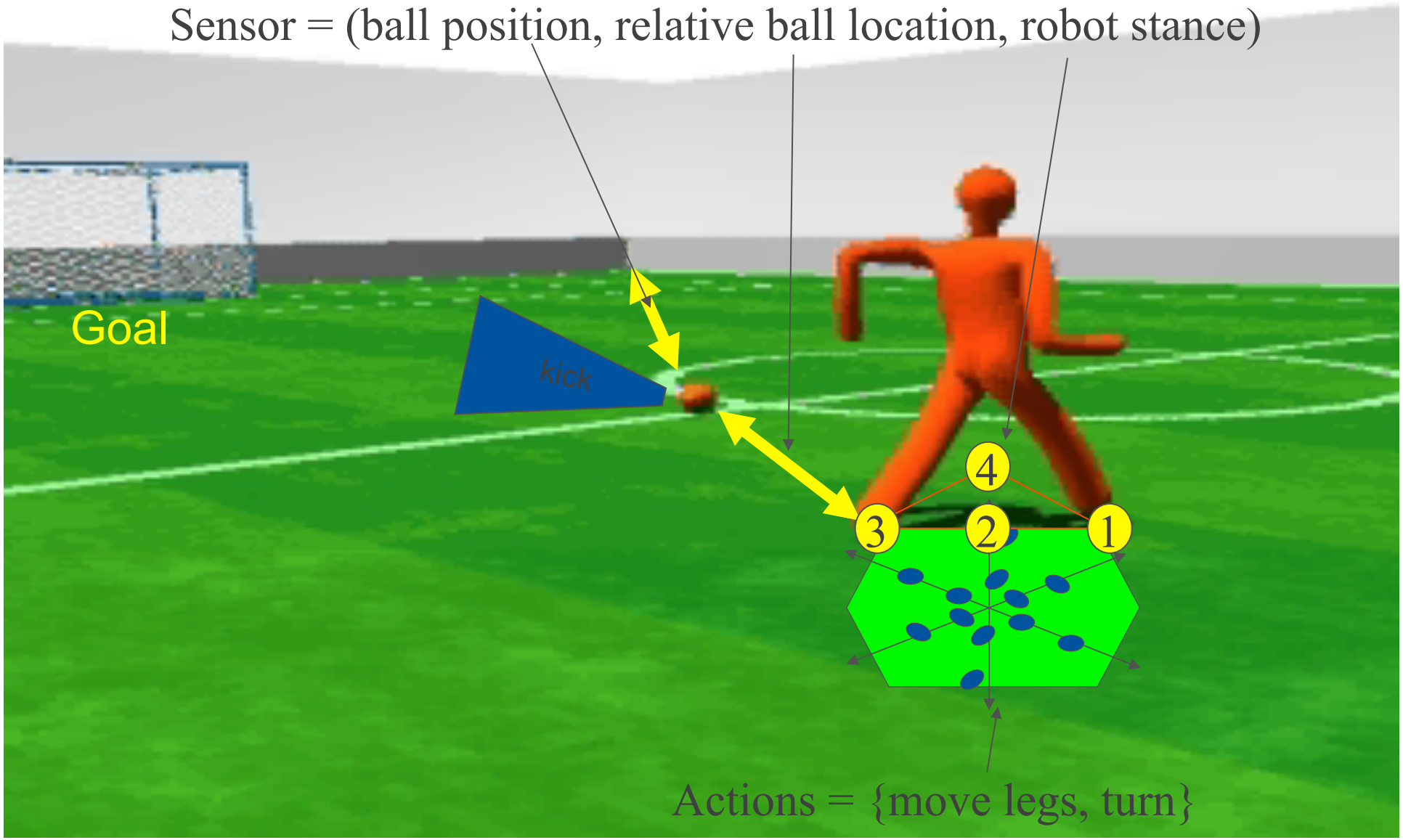








Simulated Stylised Soccer



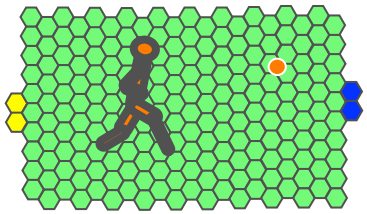

Learning to Walk

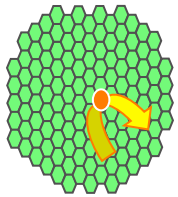

Learning to Kick

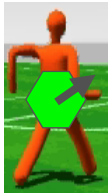

Learning to Shoot Goals


Final Learnt Behaviour

Cognitive Hierarchy – Self Configuration







World Model
State =
Global Ball Position

Behaviour Generation
Policy =
Kick ball towards goal

World Model
State =
Robot Relative Ball Position

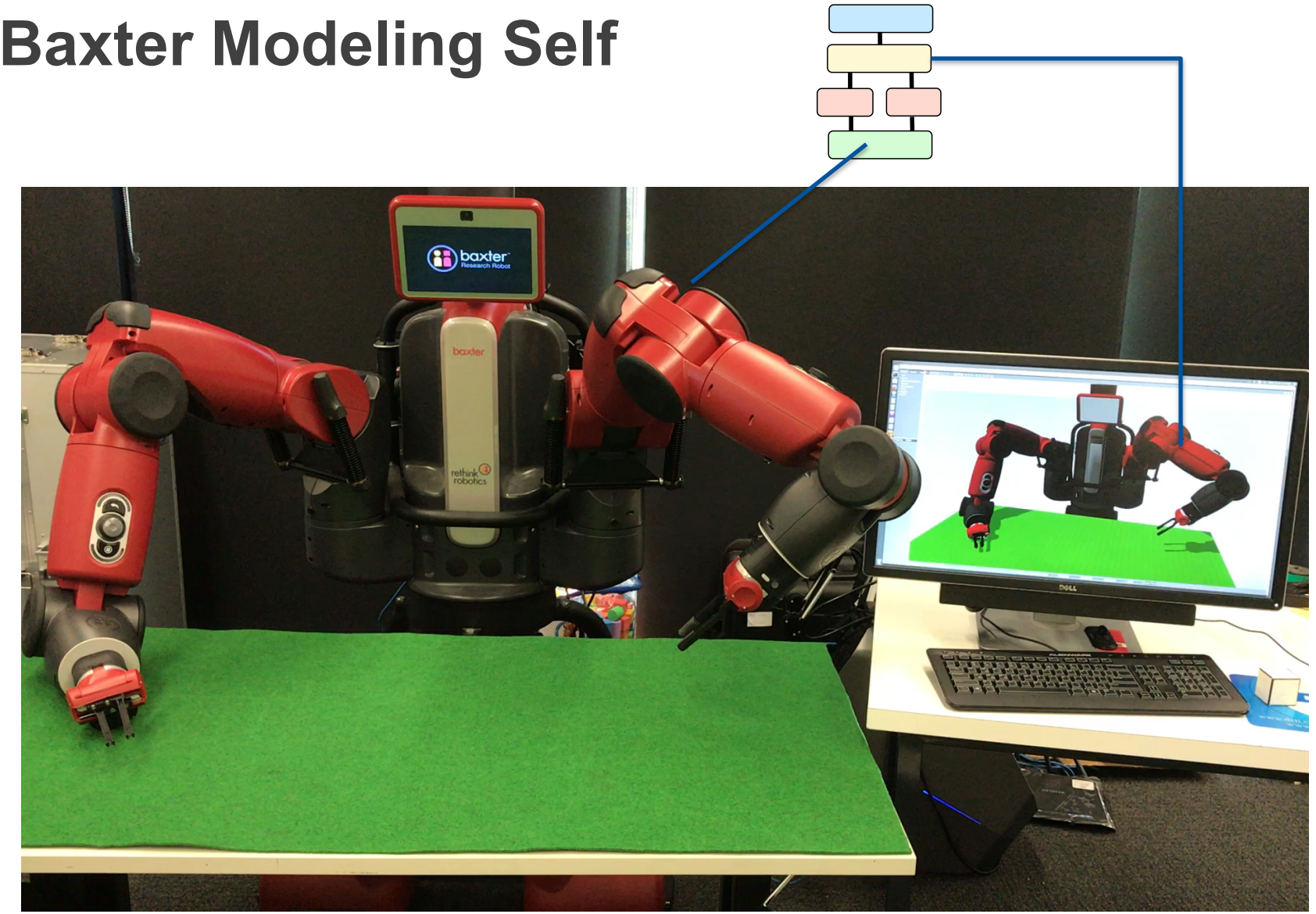
Behaviour Generation
Policies =
Approach ball and kick
in direction

World Model
State =
Robot stance

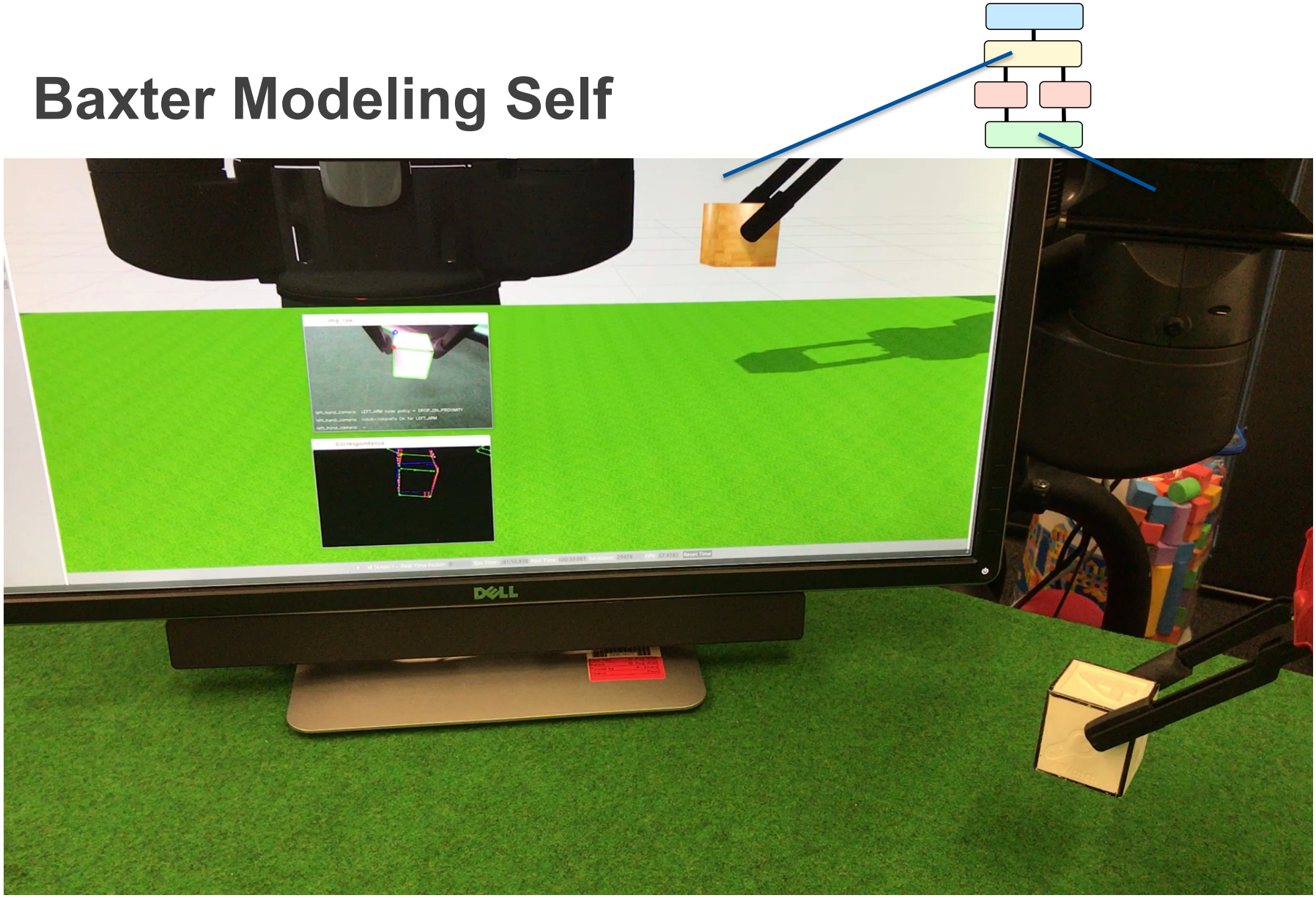
Behaviour Generation
Policies =
Walk to an adjacent tile

Environment

Baxter Modeling Self



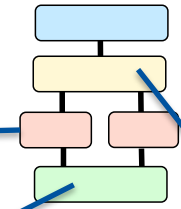
Baxter Modeling Self

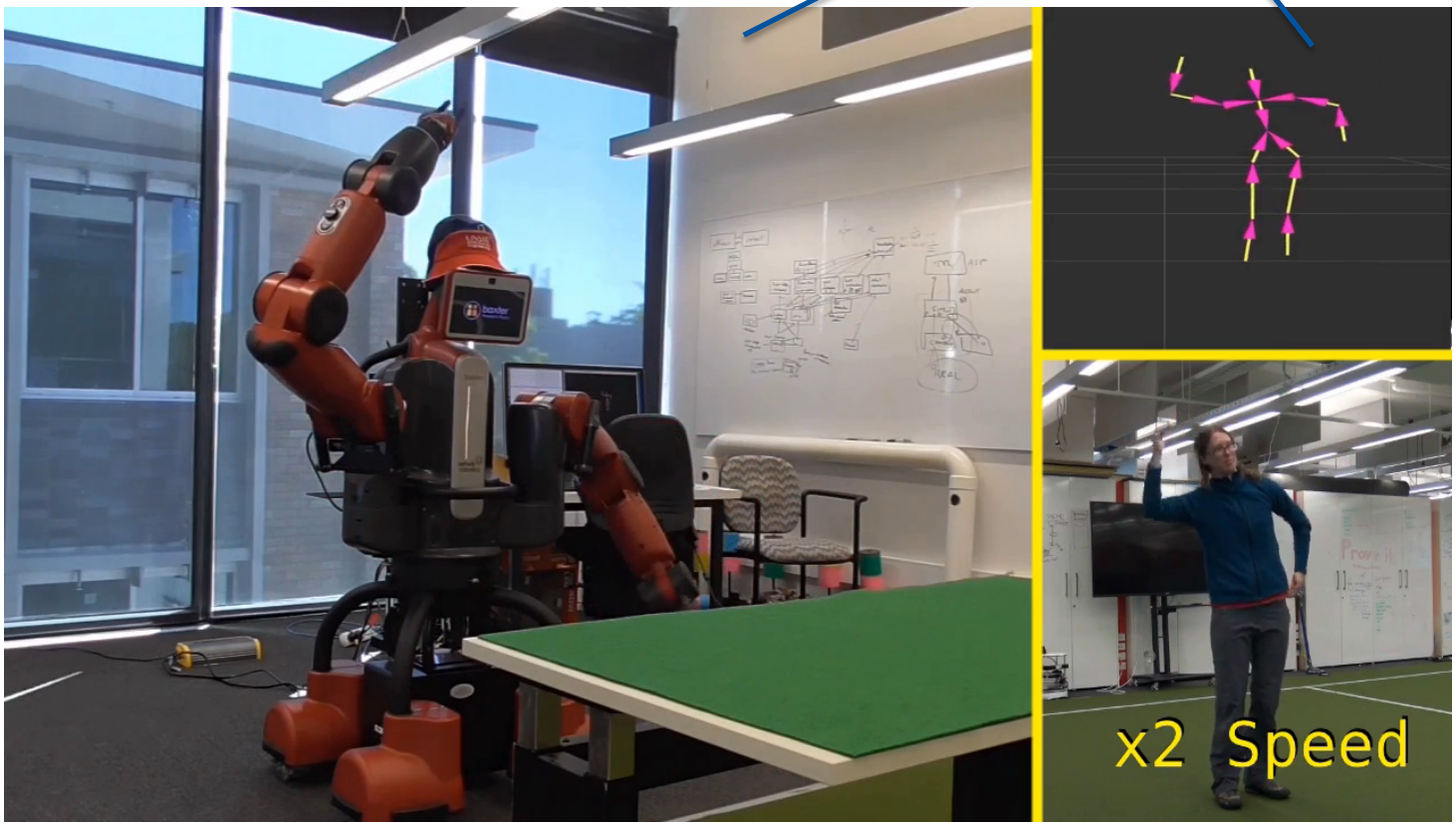


Situating the Human

Real-Time Human Pose Recognition in Parts from Single Depth Images

Jamie Shotton Andrew Fitzgibbon Mat Cook Toby Sharp Mark Finocchio
Richard Moore Alex Kipman Andrew Blake
Microsoft Research Cambridge & Xbox Incubation





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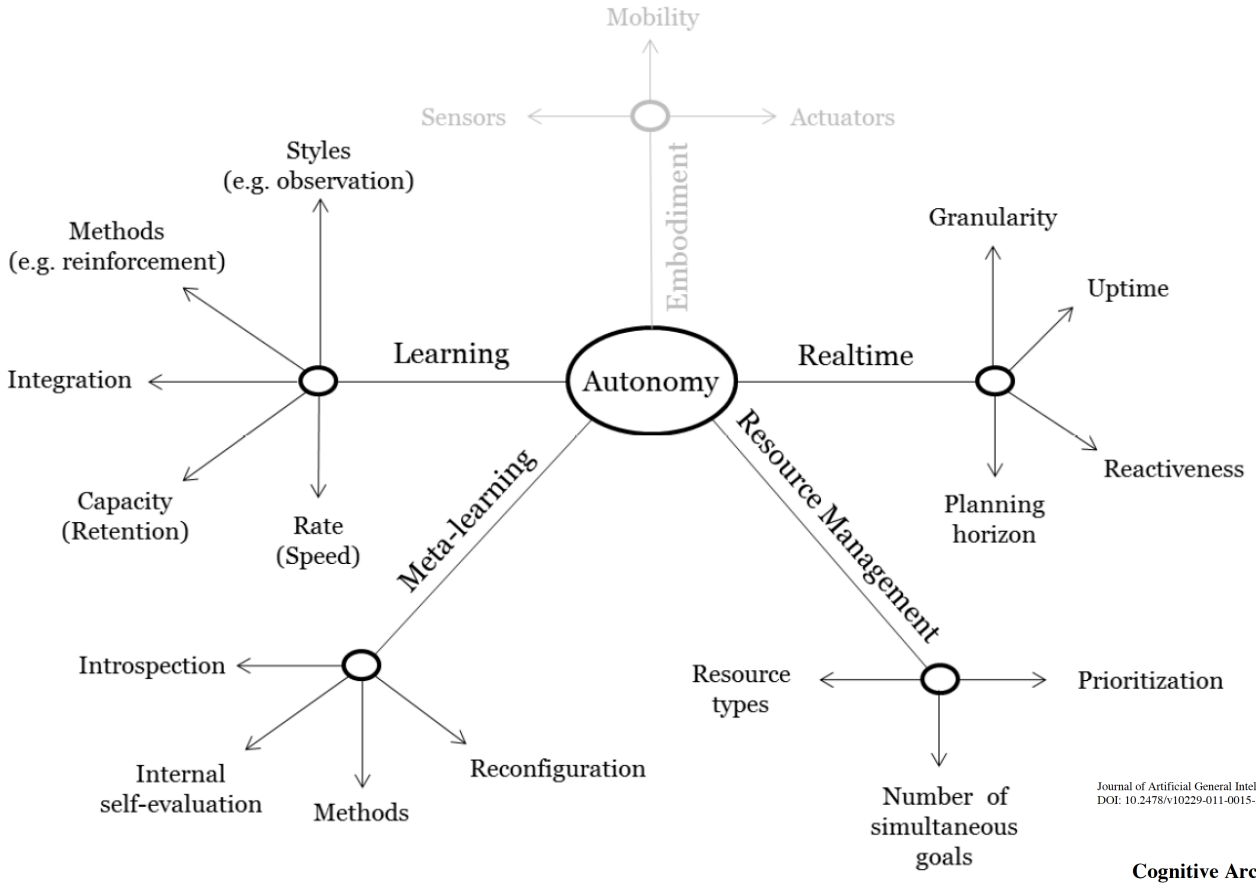
Future Work

- Update frequency
- Utility for behaviour generation
- Behaviour generation state & anytime algorithms
- Learning, meta-learning, life-long learning
- RoboCup@Home demonstrator

Architecture for Autonomous Adaptation



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DOI: 10.2478/v10229-011-0015-3

Submitted 2012-02-17
Accepted 2012-05-11

Cognitive Architectures and Autonomy: A Comparative Review

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Thank you

Questions?

Acknowledgments

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Any opinions, findings, and conclusions or recommendations expressed in this publication are those of the authors and do not necessarily reflect the views of the AOARD.