Neural Process Models of Intentionality

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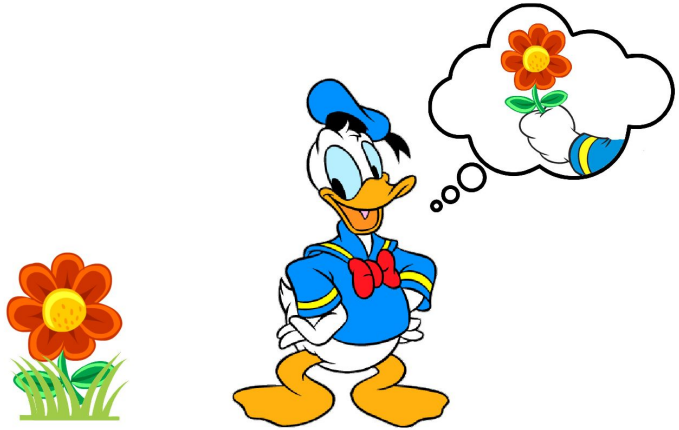
Spectrums of DFT

- Models capturing psychophysical data
- Models capturing behavioral competences
- How far can we take autonomous behavior?



Intentionality

> *"The capacity of the nervous system to generate mental states that are 'about' things in the world."*

- How may intentional states emerge from neural processes?
- How are intentional states stabilized in time?
- Under which circumstances are intentional states destabilized?

Intentional States

- Defined through a **content** and a **psychological mode**

World-to-Mind Direction of Fit

- I am picking a *red flower* in front of me (Intention-in-Action)
- I will pick a *red flower* later in the park (Prior Intention)
- I want a *red flower* (Desire)

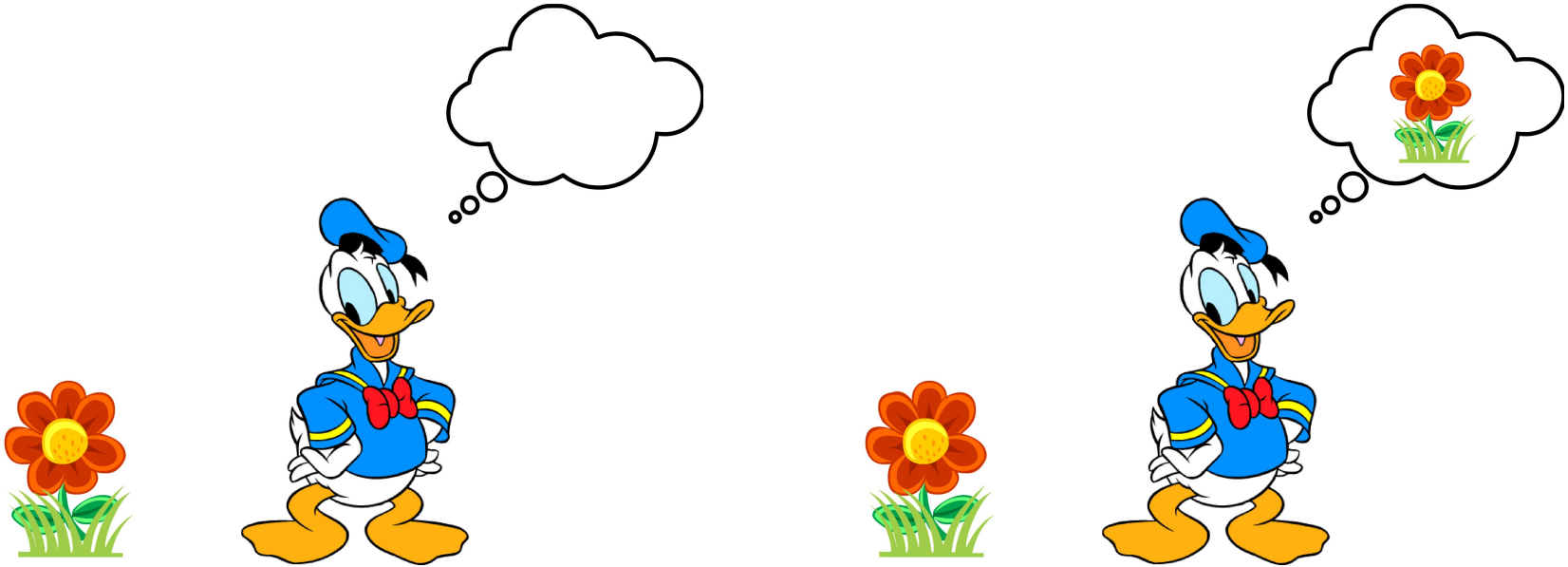
Mind-to-World Direction of Fit

- I am seeing a *red flower* in front of me (Perception)
- I recall a *red flower* growing in the park (Memory)
- I believe *red flowers* have a green stem (Belief)

content

[Searle,1983]

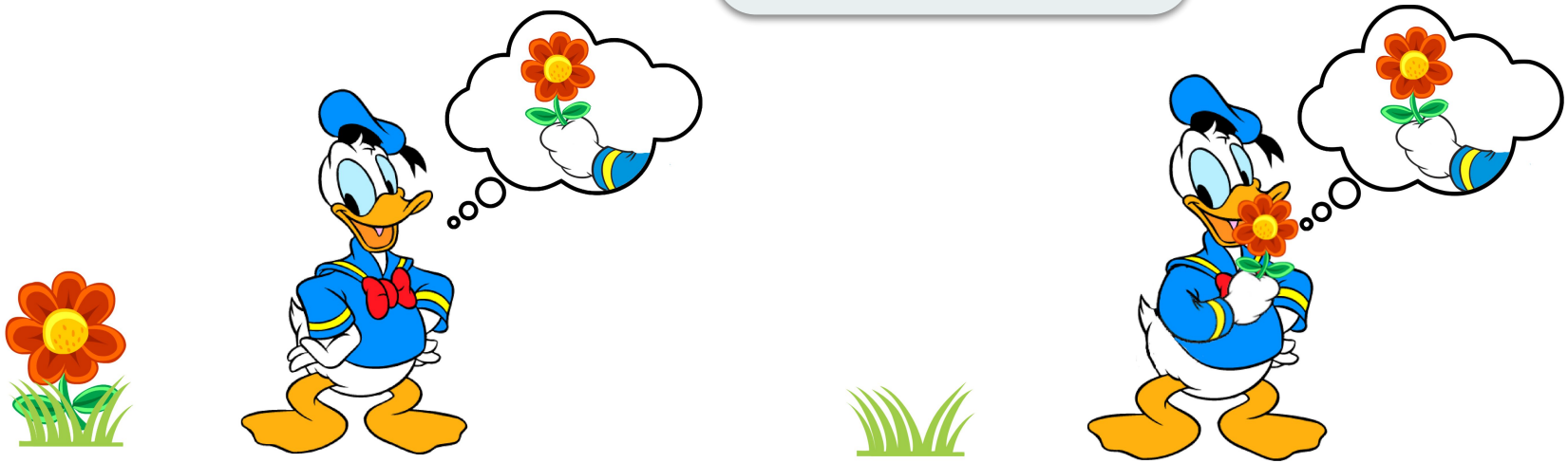
Directions of Fit: Mind-to-World



Example: Perception

Directions of Fit: World-to-Mind

Condition of Satisfaction:
Is the fit achieved?



Example: Intention-In-Action

Directions of Fit: Summary

Mind-to-World Direction

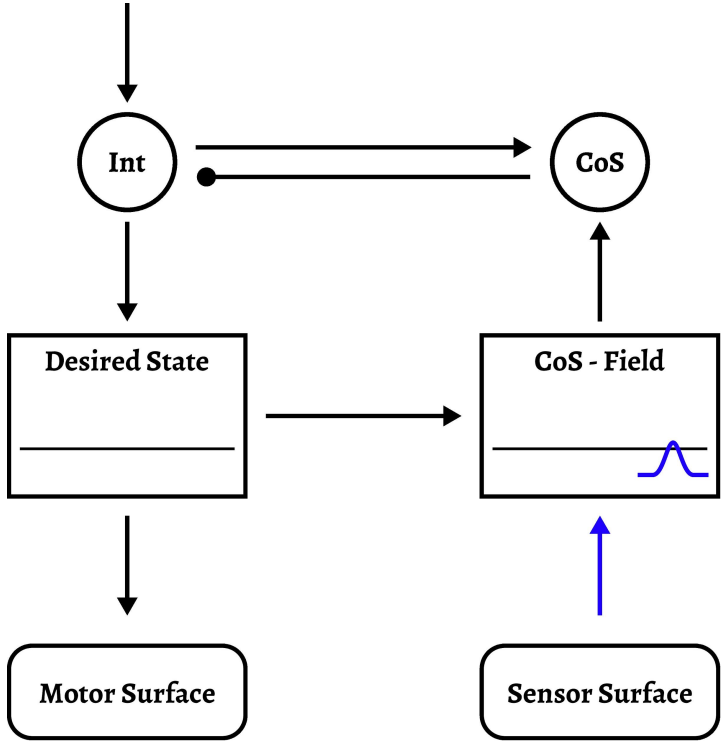
- (perceptual) intentionality
- a mental state is **accompanied** by a fulfilled CoS
- possibility of error (e.g. misperception)

World-to-Mind Direction

- (motor) intentionality
- a mental state is **terminated** by a fulfilled CoS
- errors in execution lead to a Condition of Dissatisfaction

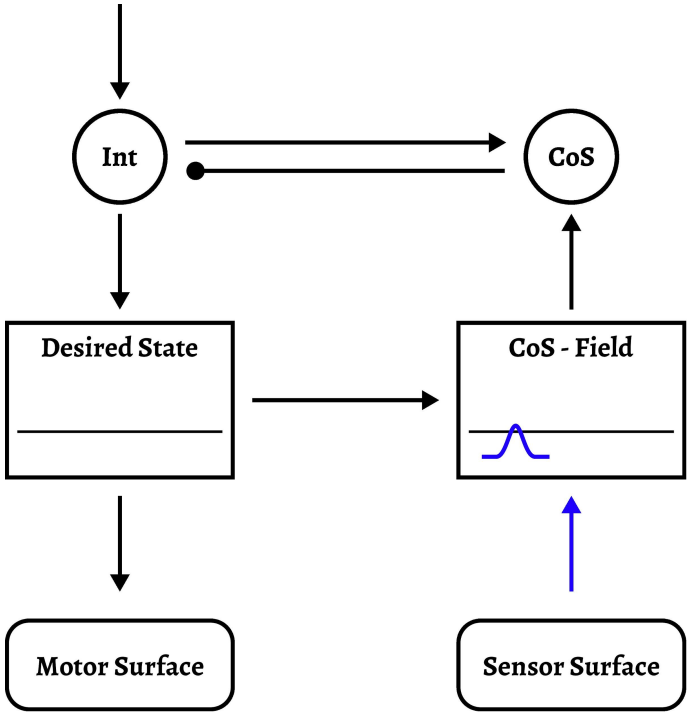
A neural Process Model

- Detects CoS based on sensor information
- Represents action initiation and termination
- Drives motor behavior



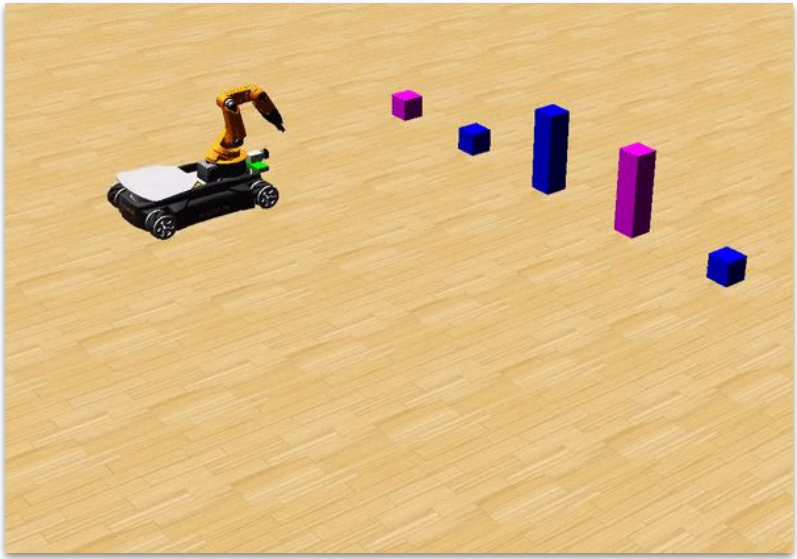
[Sandamirskaya and Schöner, 2010]

Condition of Satisfaction Network



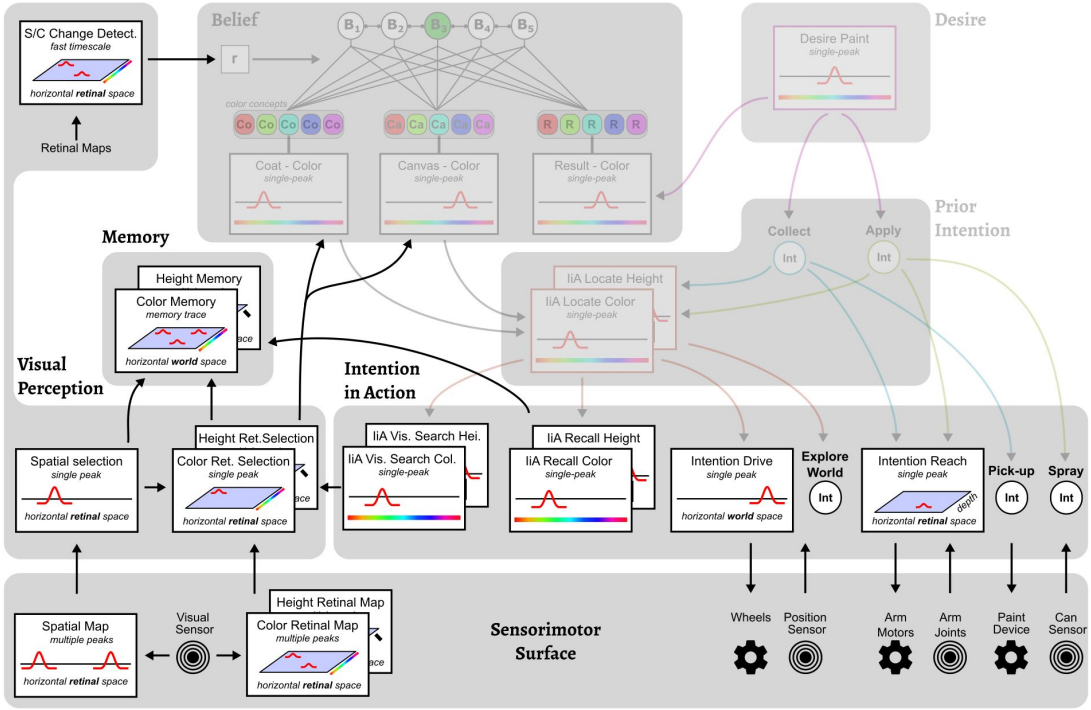
A simple Toy Scenario

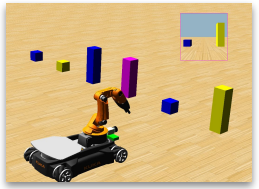
- Scenario includes six different psychological modes
- Behavior emerges from autonomous transitions between intentional states
- Stabilized intentional states make up experience
- Experience allows the formation of categorical beliefs



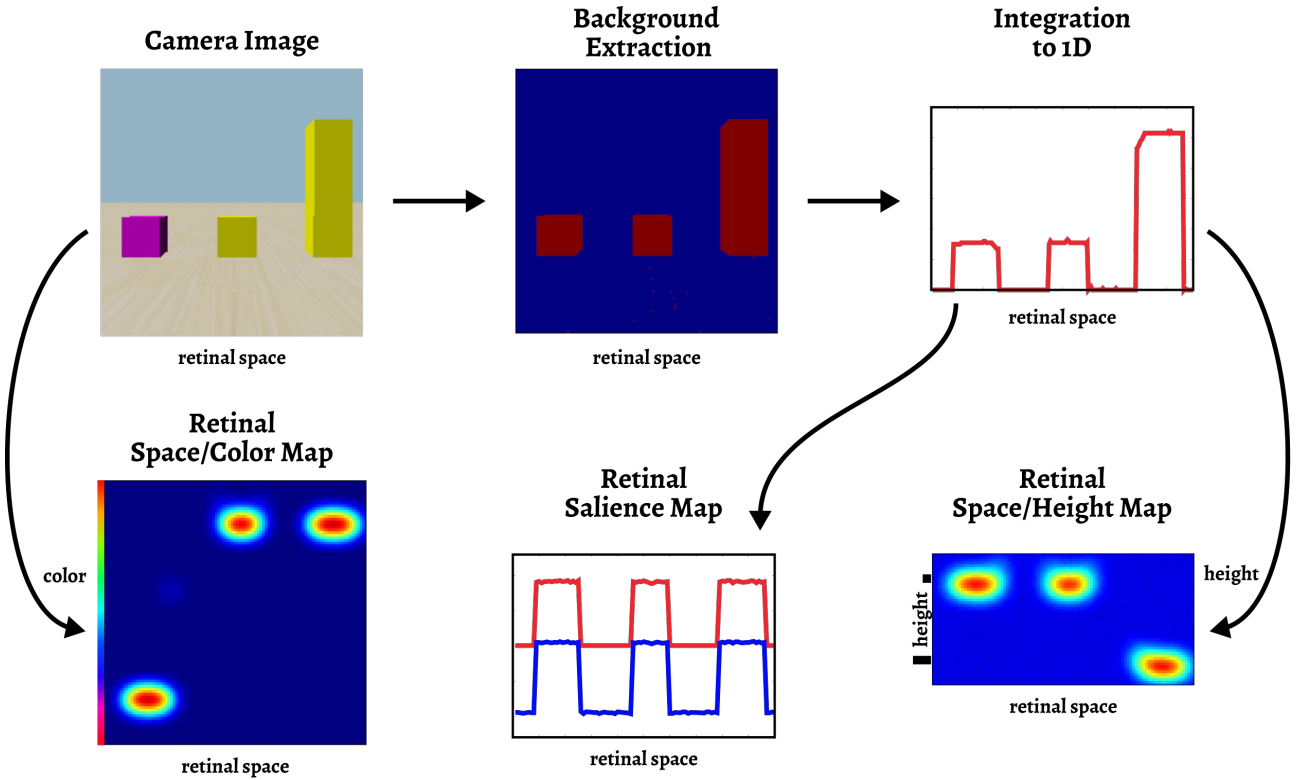
[Tekülve and Schöner, 2019]

Architecture Sketch

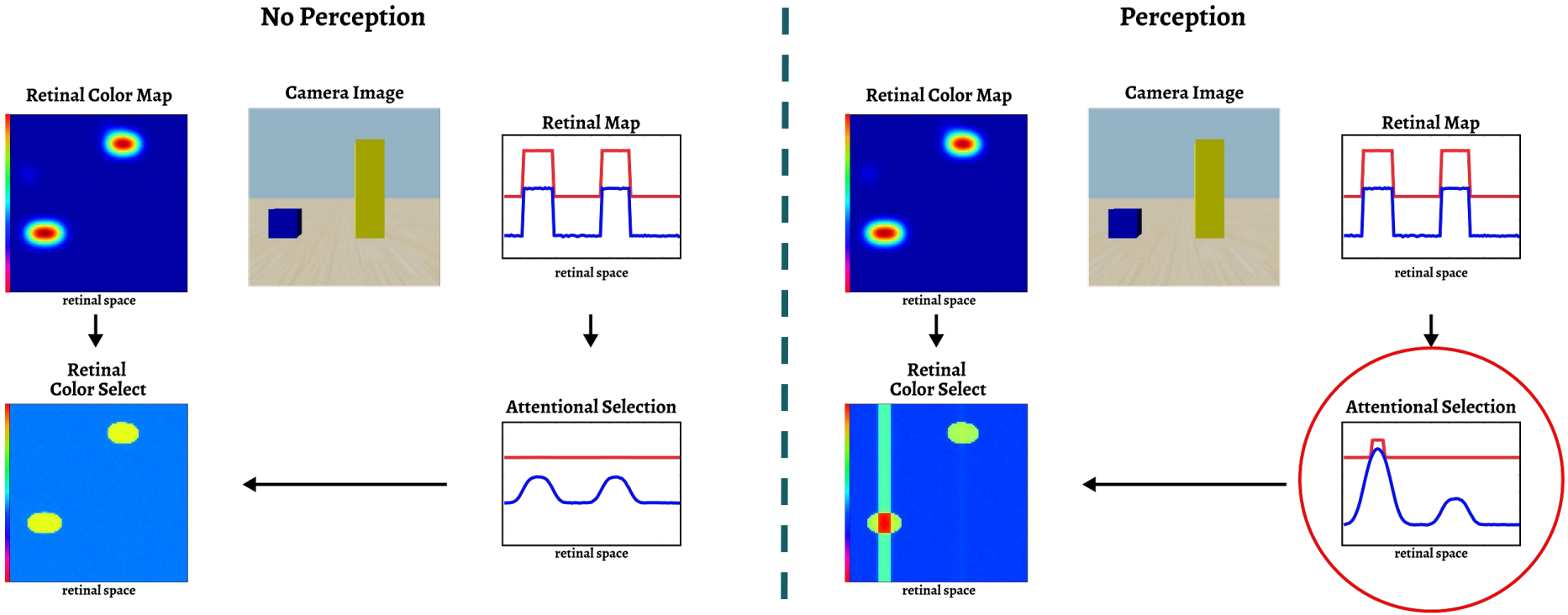




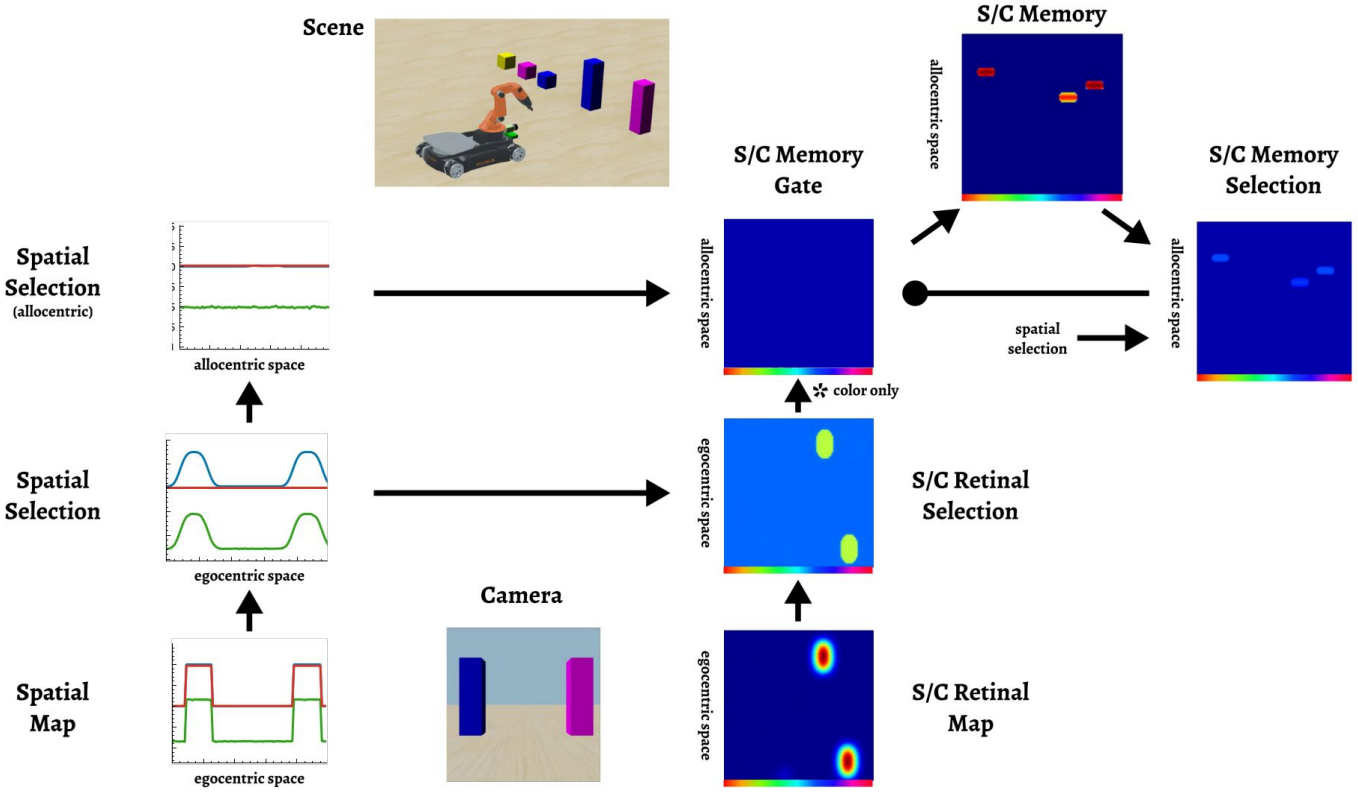
From Sensor to Field



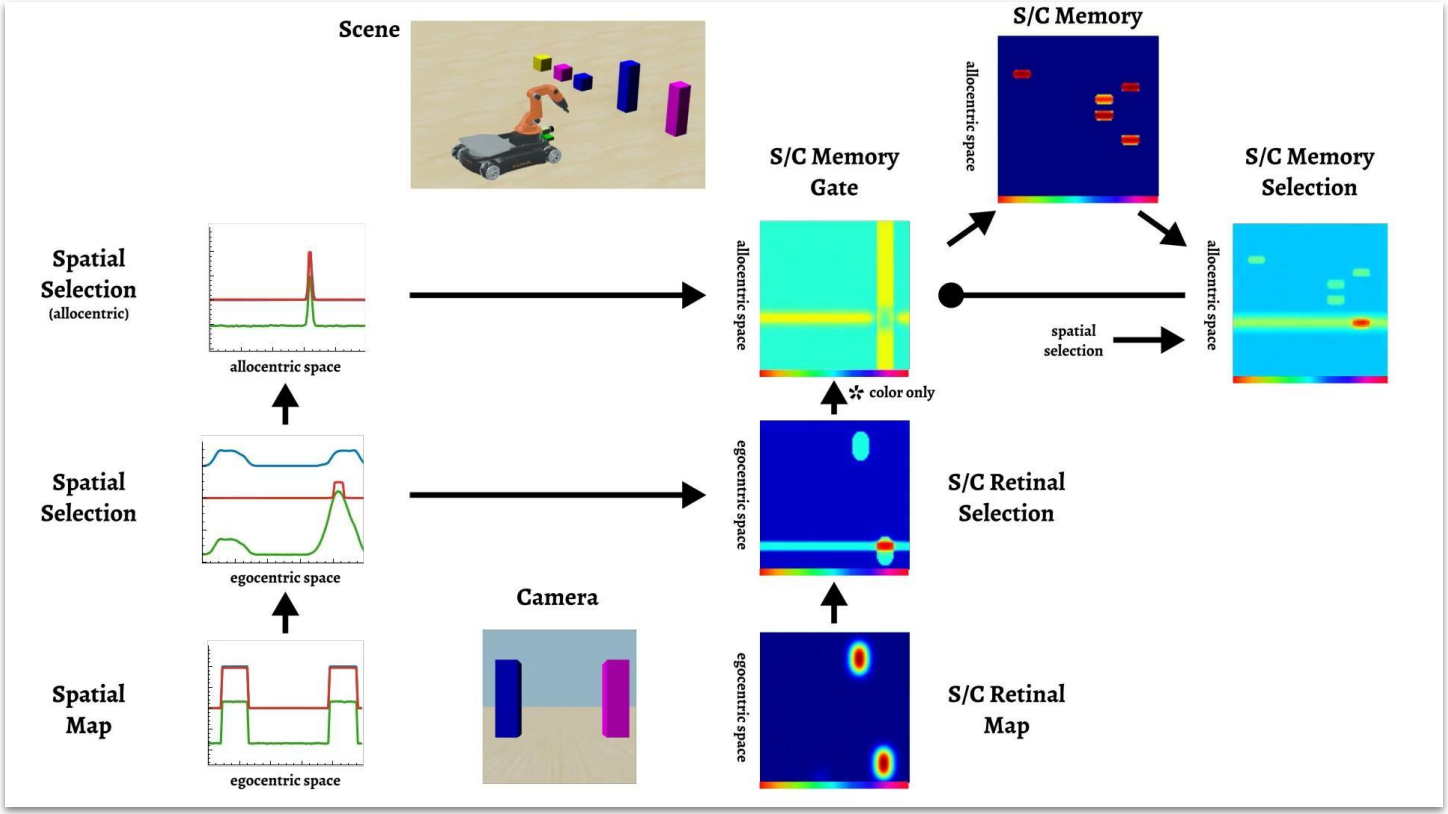
Process Model: Perception



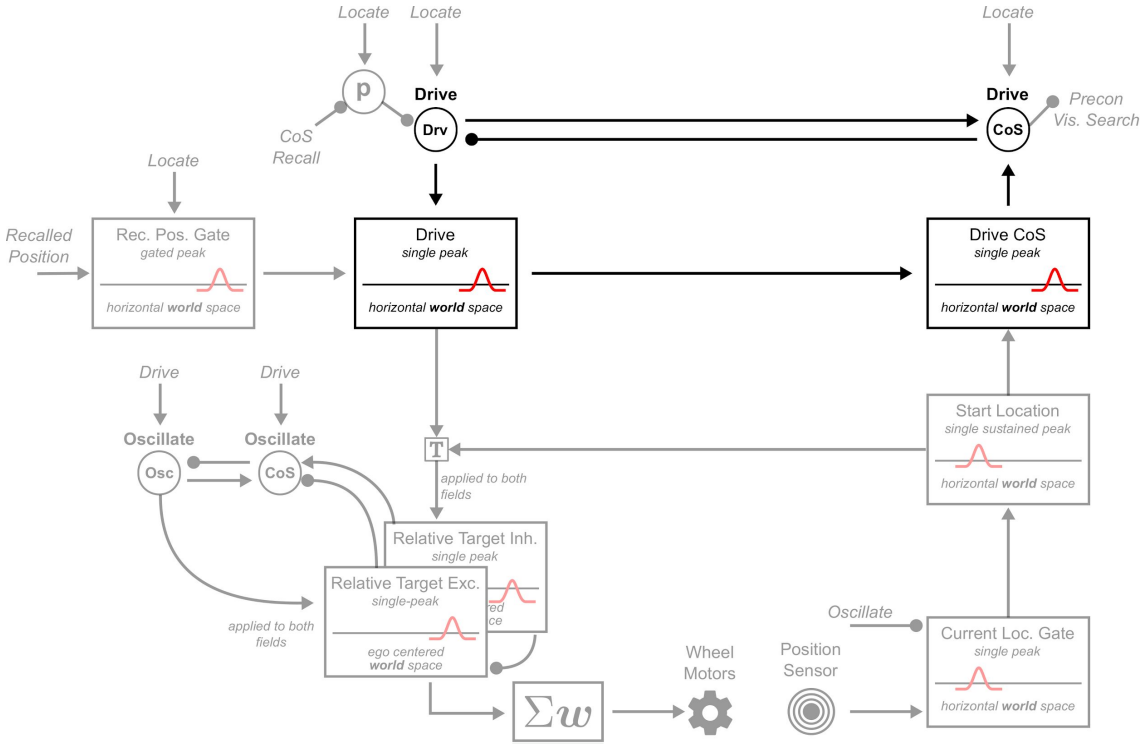
Stabilized Perception leads to Memory Buildup



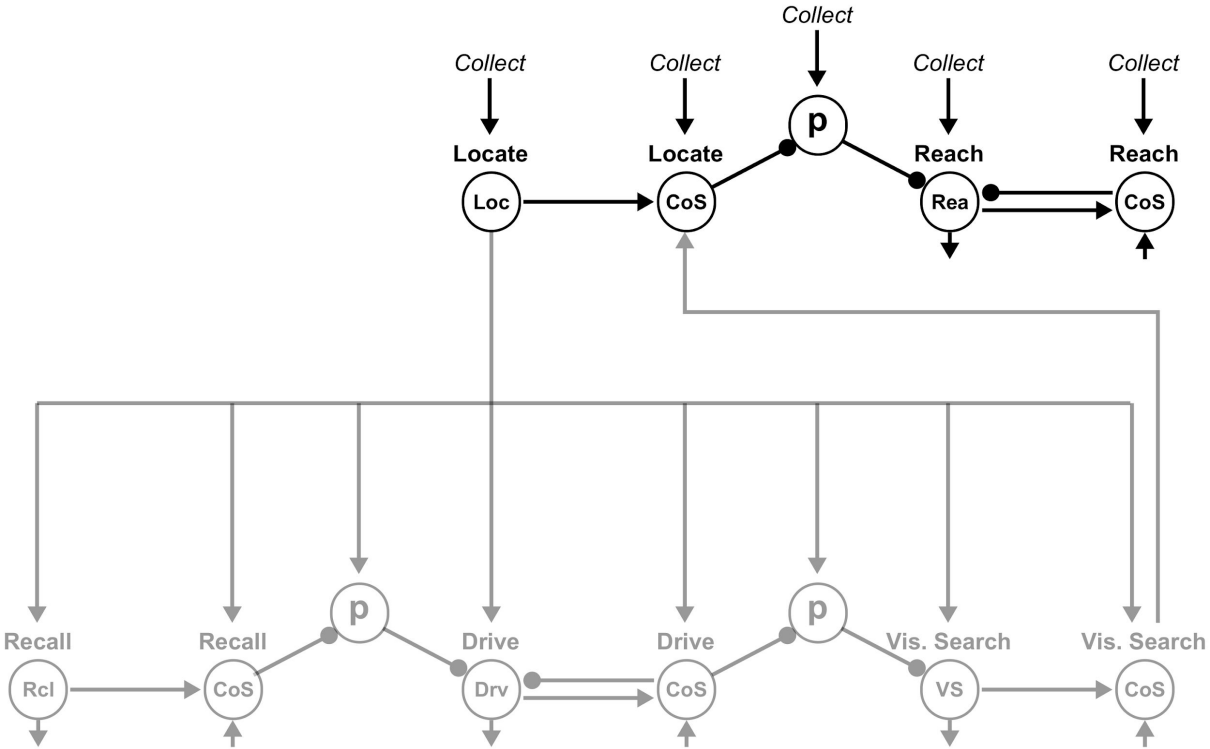
Stabilized Perception leads to Memory Buildup



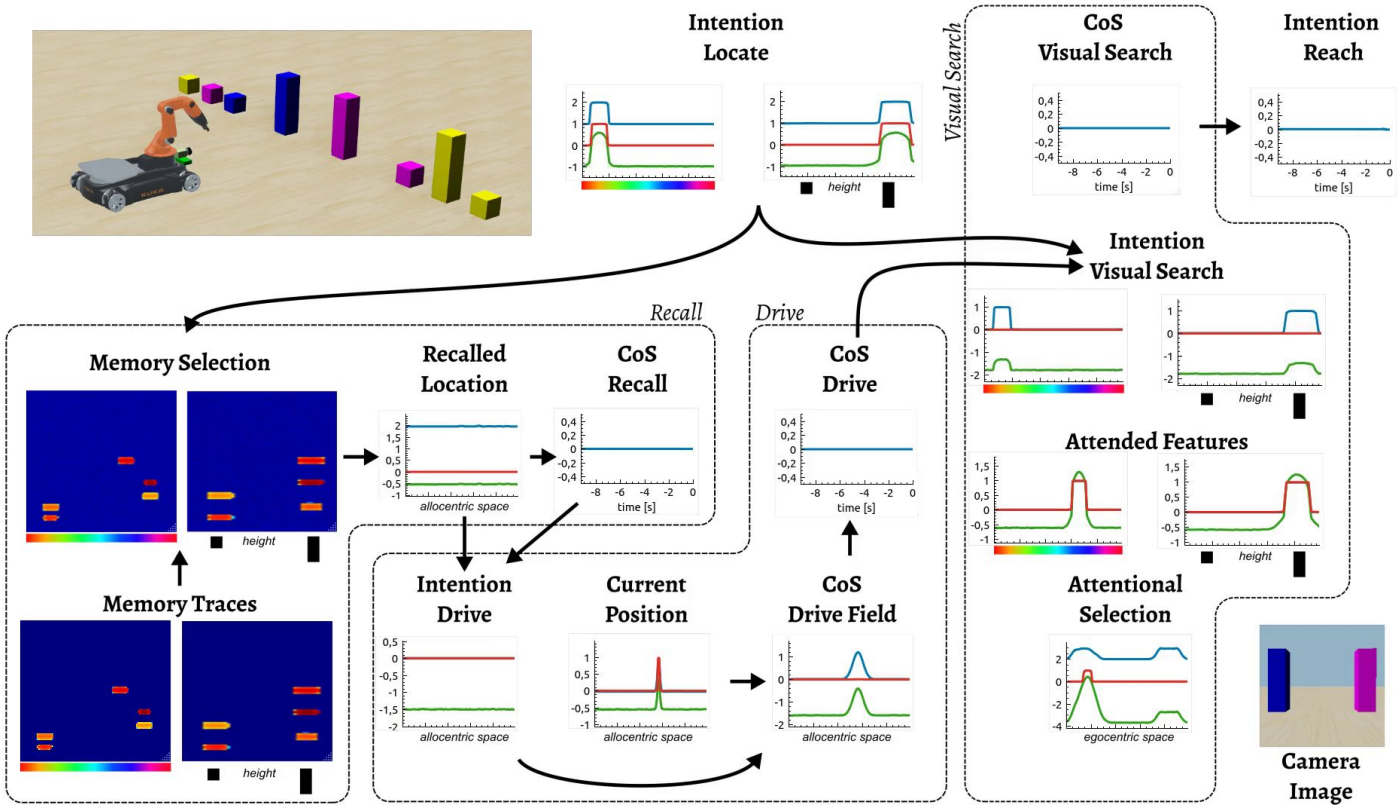
Example: Goal-Directed Driving



Prior Intentions



Instabilities facilitate Sequences



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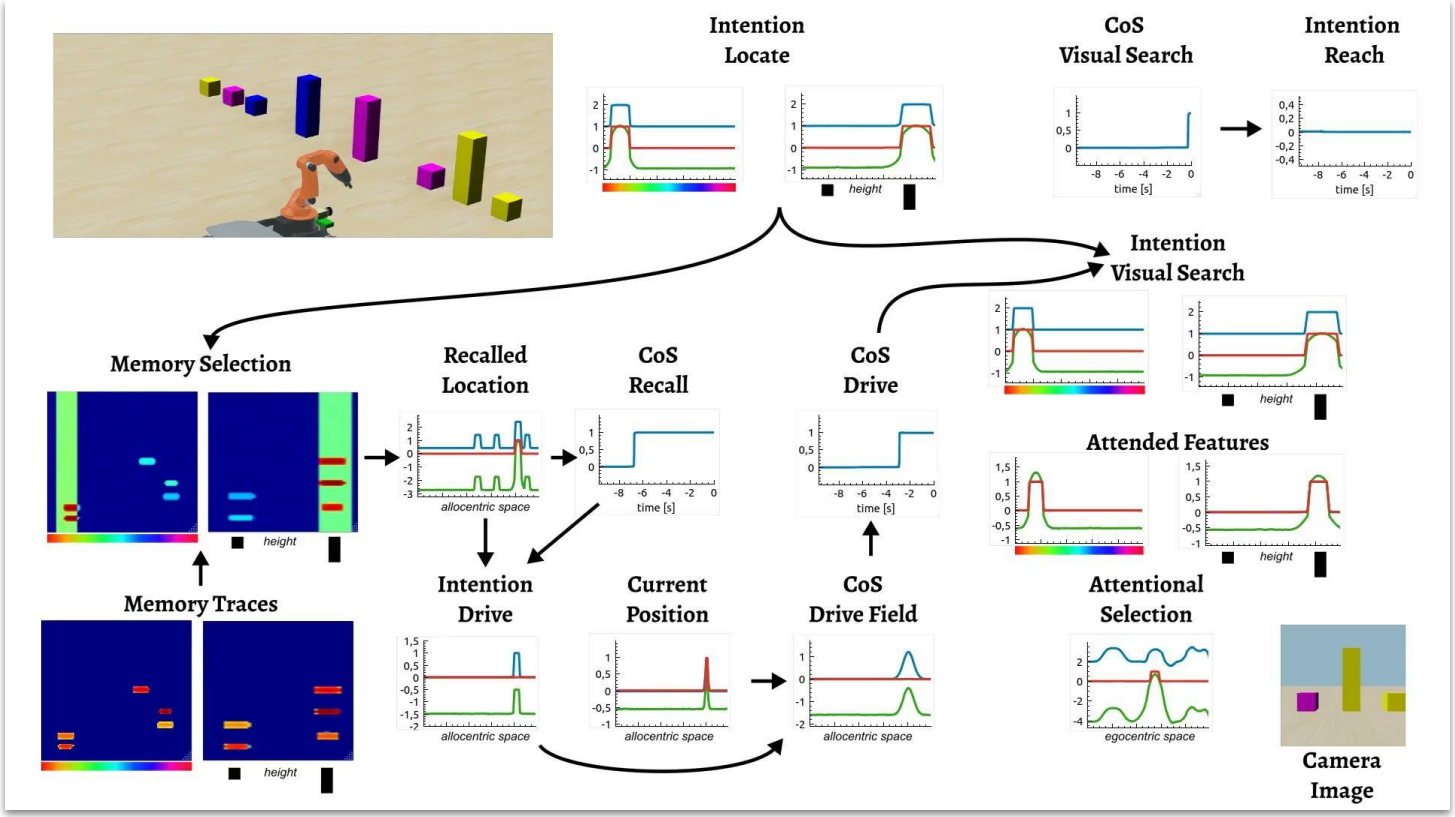


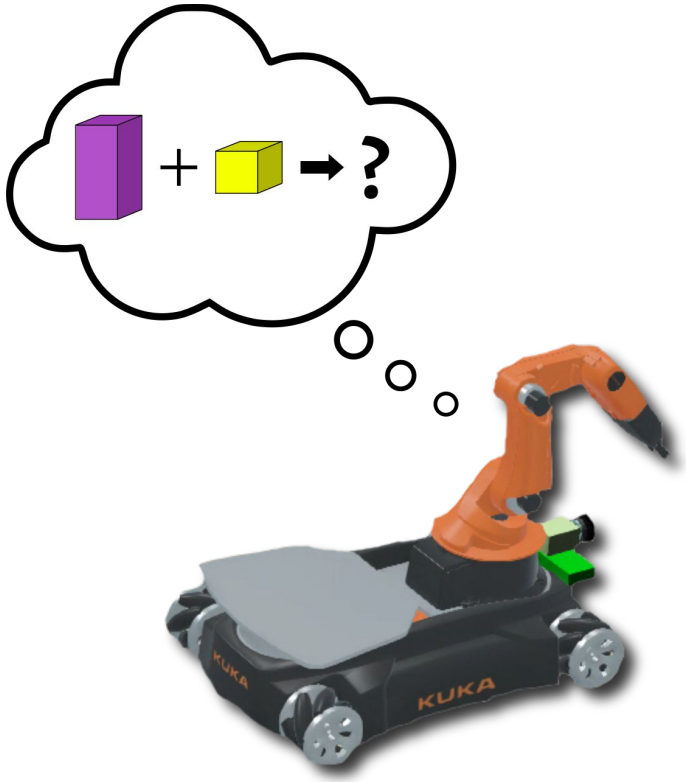
Autonomous Learning

➢ Learning from self generated experience

- Autonomous Action
  - Intention-in-Action
  - Prior Intention
- Experiences
  - Perceptions
  - Memories

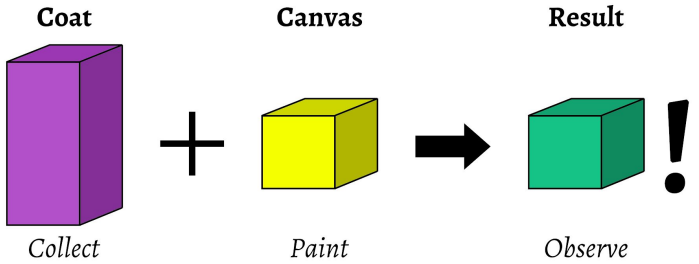
➢ Neural Constraints:

- Local learning
- Robustness against catastrophic forgetting
- Learnt representations must be accessible

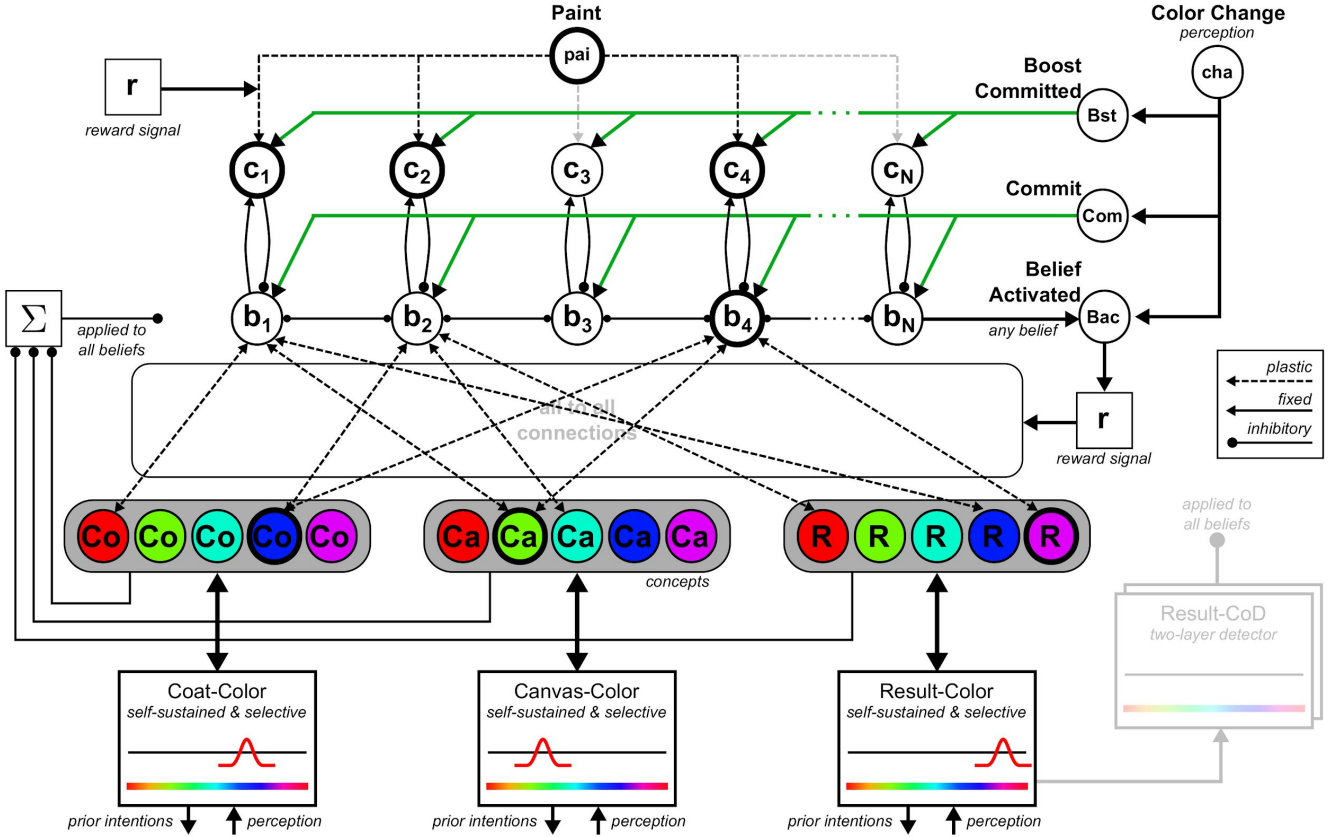


Beliefs

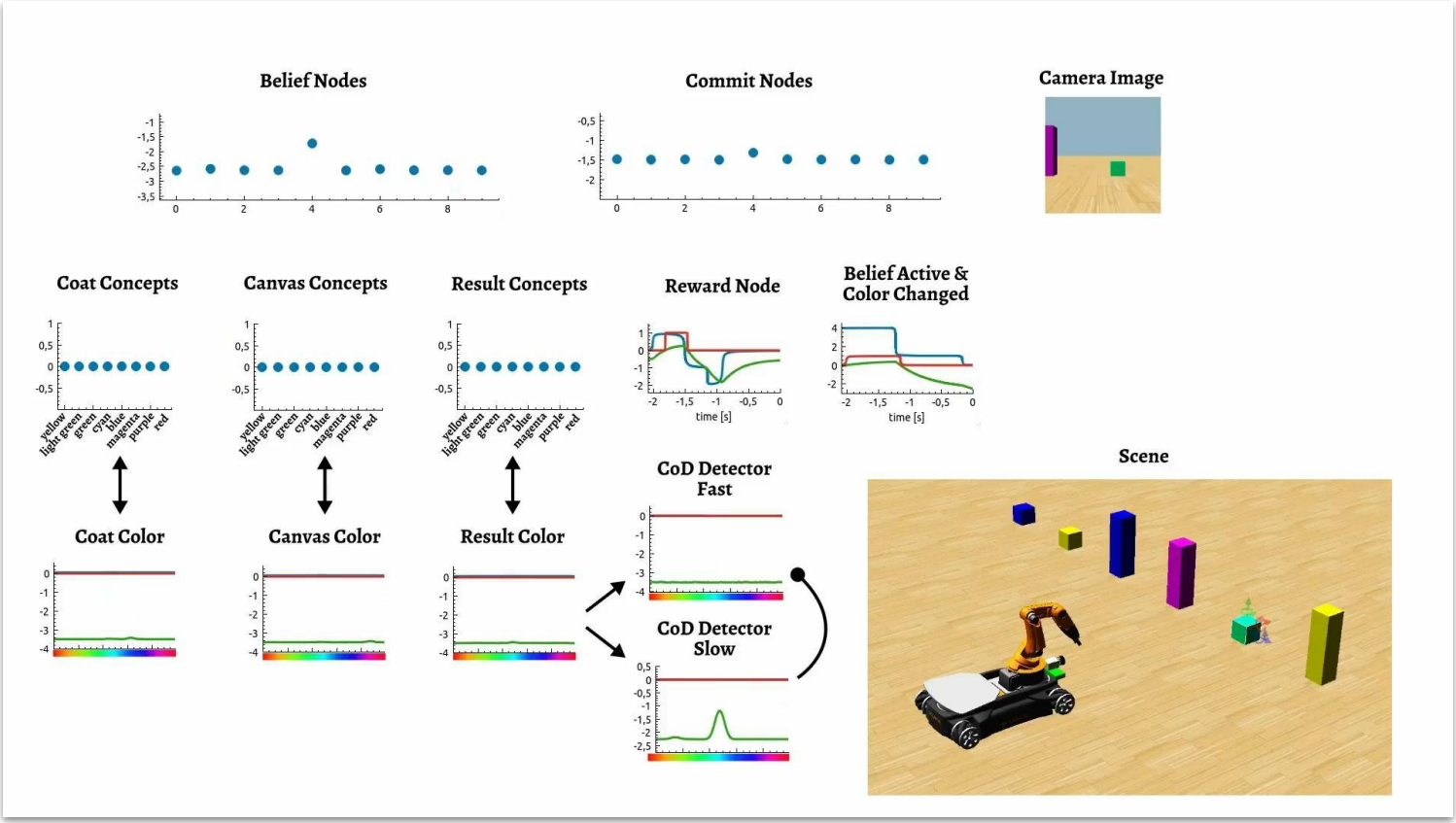
- Learning from a single episode
- Cued activation to guide behavior
- Rejection in the face of conflicting evidence



Belief Architecture



Belief Recall and Rejection



Conclusion

- From the sensorimotor surface to abstract representations
- Process models of different psychological modes
- Autonomous learning requires infrastructure