Learning New Tasks with Situated Interactive Instruction

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Shiwali Mohan and John E. Laird

UNIVERSITY OF MICHIGAN

Interactive Taskable Agents

Our goal is to design long-living agents that dynamically expand their task knowledge and skill-set through their experiences in novel environments.

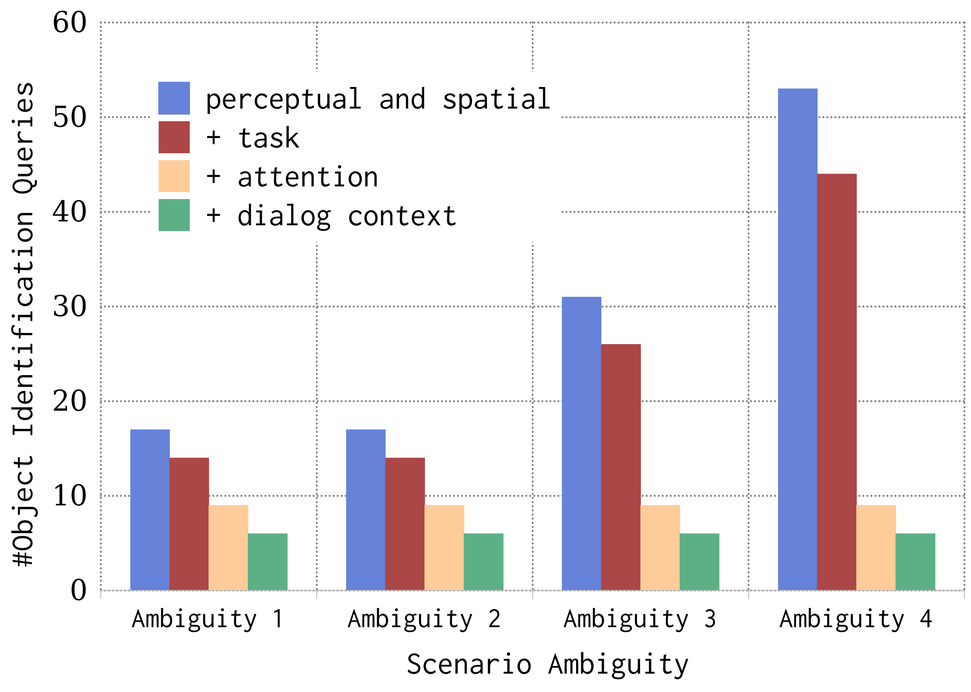
Learning new tasks requires learning relevant features in perception, spatial relationships, goals, task decomposition structure, policy etc.

Situated Comprehension

Human language is *contextual*, *flexible*, *efficient*, *effective*, *ambiguous*
The Indexical Hypothesis (Glenberg and Robertson 1999)
- speaker and hearer share ground
- language is reference to elements in the common ground

The Indexical Model (Mohan, Mininger, Laird 2013)
1. Index words and phrases to referents
   - NN/ADJ perceptual classification
   - NP set of objects ...
2. Extract domain-knowledge associated with referents
3. Mesh under syntactic, knowledge-based constraints

Referring expressions are ambiguous (it, that object, the blue cube, ...)
Use of RE is influenced by relative salience of objects and partners.
The Givenness Hierarchy (Gundel 1993):
in-focus (it) > activated (this, that rectangle) > uniquely-identifiable (the green rectangle) > type-identifiable (a green rectangle)



Human speakers and hearers rely on shared experience and knowledge
- *Take the trash out to the curb.*
- *Take the trash out.*

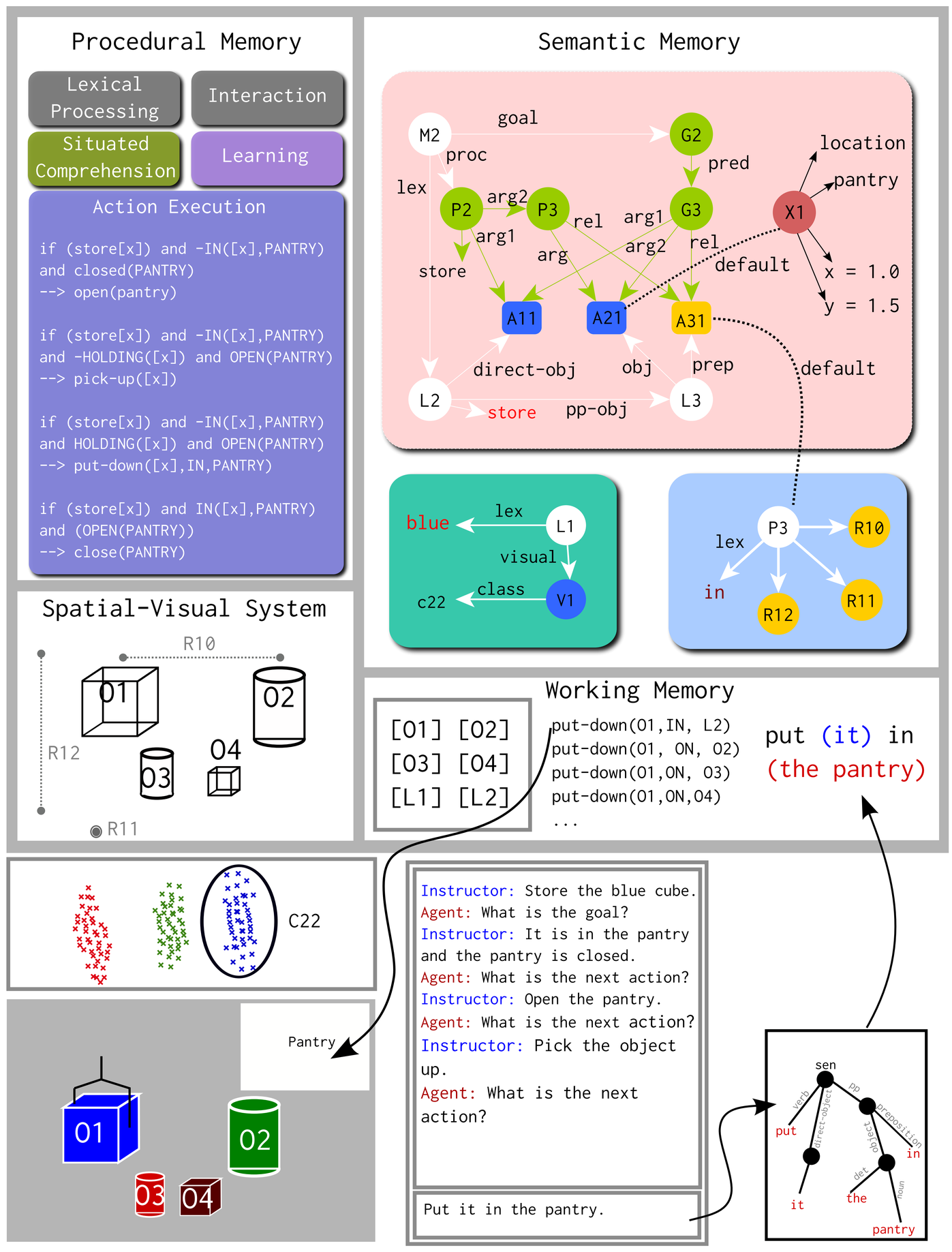
Our agent can exploit the difference in instructions to reason about the arguments of task verbs and uses this experience to fill up unknown or not-specified values.

Situated Interactive Instruction (SII)

Tutorial interactions that occur when an expert and a learner collaborate on a task are
- *rich in useful information*, identifies relevant features, goals, task decomposition structure
- *concept-level*, exploits shared perceptions, common domain knowledge, experience
- *mixed-initiative*, distributes the onus of learning between the learner and the expert
- *alternative*, *complimentary* to learning from demonstration (LfD)

Rosie Framework

Developed in the Soar cognitive architecture (Laird 2012)
Is reactive to real time changes (50 ms perceive-decide-act cycle)
Learns online, acquires a variety of concepts: perceptual classification & categorization, spatial configuration, goal-oriented hierarchical tasks, games and puzzles



Task Learning

What?

parameters
Store the green cylinder
`store(O2, pantry, IN(O2, PANTRY))`
subtasks
`store: open,move[pick-up, put-down],close`
goals
`in(O2,pantry) and closed(pantry)`

How?

policy
`if [state,task] then execute(subtask)`
model
`if [state,task] then [next-state]`

When?

availability
`if [state] then available(task)`
termination
`if [goal] then terminate(task)`

Learning occurs in two different phases (Mohan and Laird 2014)
1. **interactive task execution**
   if the agent does not know the policy for a state, it explores available options till depth K. if it is successful, it executes it, else it asks a questions
2. **retrospective explanation**
   the agent looks back at the instructions and deduces why the instructed actions were useful in achieving the goal of the task and learns concepts. a variation of explanation-based learning (DeJong 1986)

Learning is *comprehensive*, *general*, *transferrable*, *mixed-initiative*

Transfer

Mixed-initiative