

Establishing Common Ground for Learning Robots

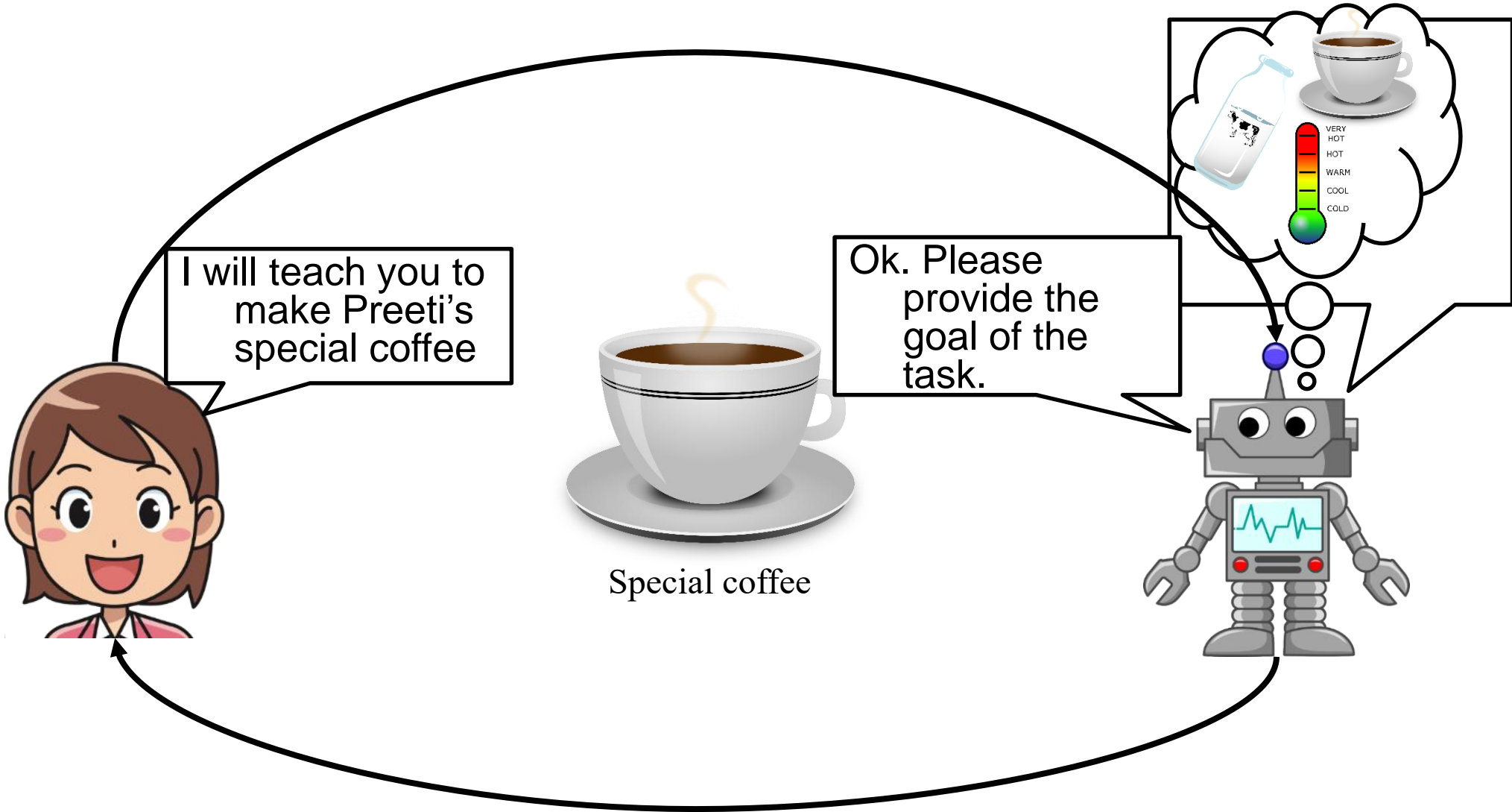
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University of Michigan, Ann Arbor

RSS 2018 Workshop on Models and Representations for
Human-Robot Communication

Common Ground with Learning Robots

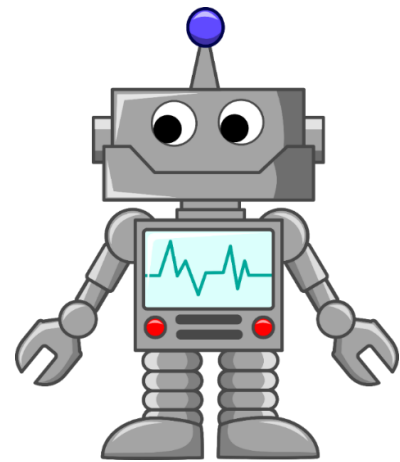
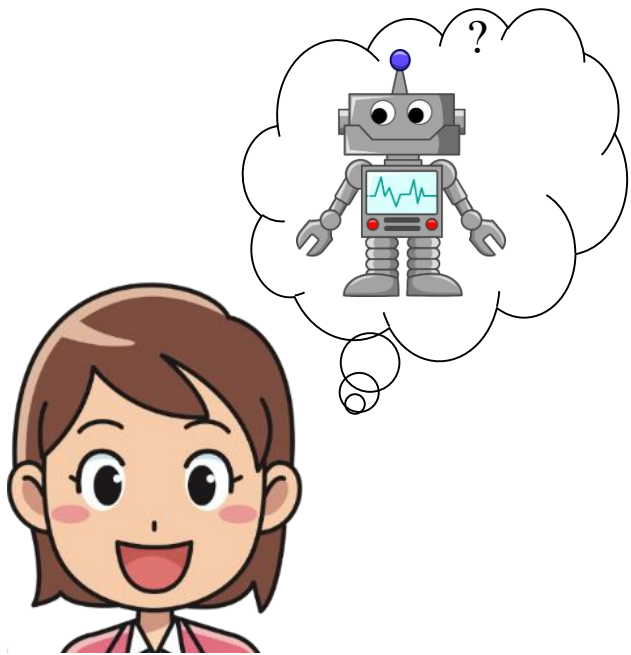


Common Ground with Learning Robots



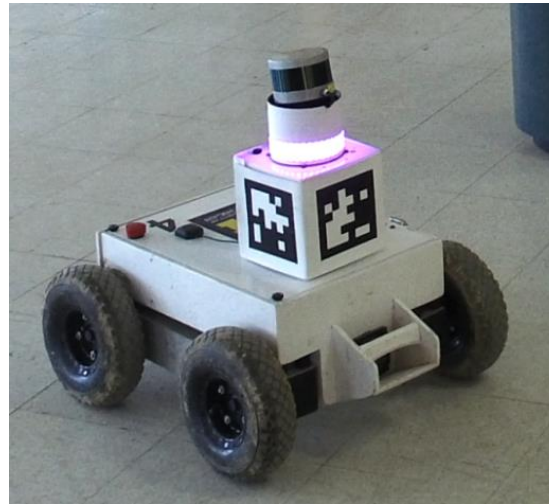
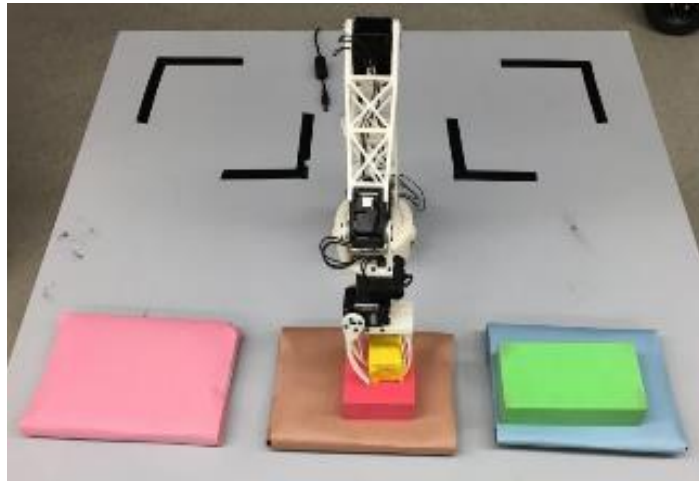
Clark, Herbert H., and Deanna Wilkes-Gibbs. "Referring as a collaborative process." *Cognition* 22.1 (1986): 1-39.

Characterize knowledge crucial for task learning



Rosie – Interactive Task Learning Robot

- Rosie
 - Learns from natural interactions with humans
 - Knows 50+ games and puzzles, and mobile delivery tasks

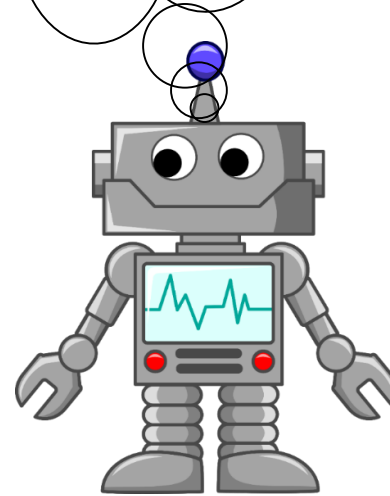
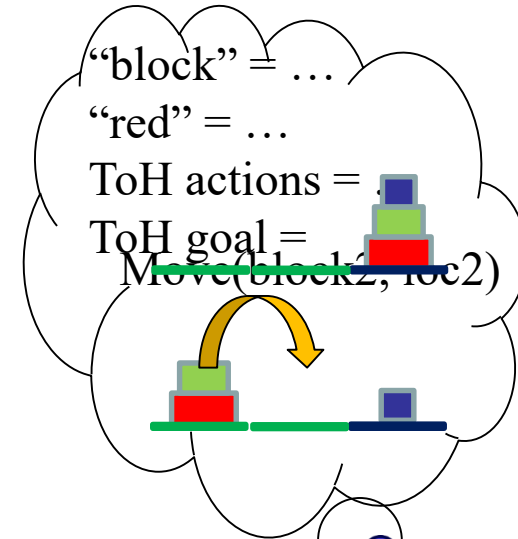
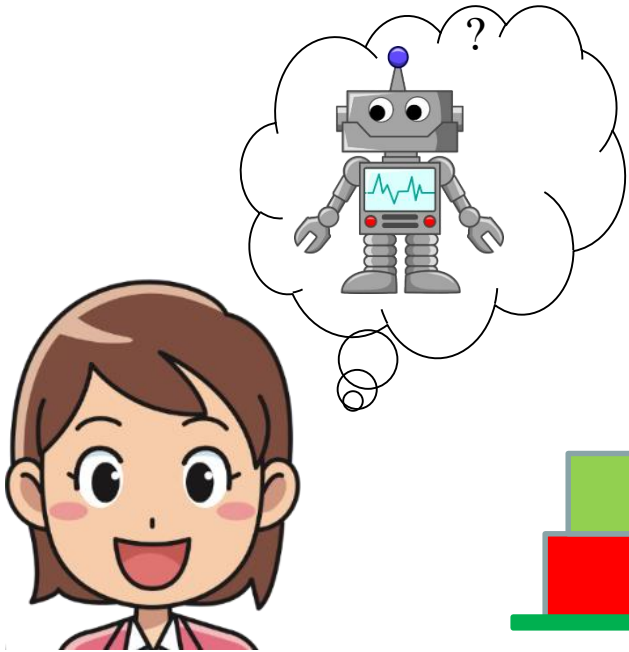


Kirk, J., Mininger, A., Laird, J. 2016: Learning task goals interactively with visual demonstrations. Biologically Inspired Cognitive Architectures. New York, New York, 2016.

Mininger, A., & Laird, J. 2016: Interactively Learning Strategies for Handling References to Unseen or Unknown Objects. In Proceedings of the Fourth Annual Conference on Advances in Cognitive Systems.

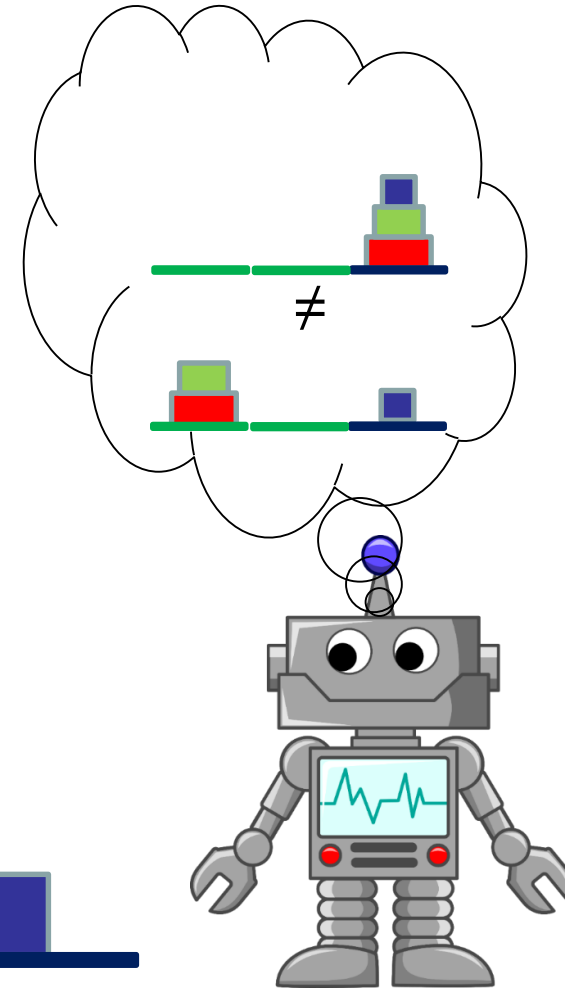
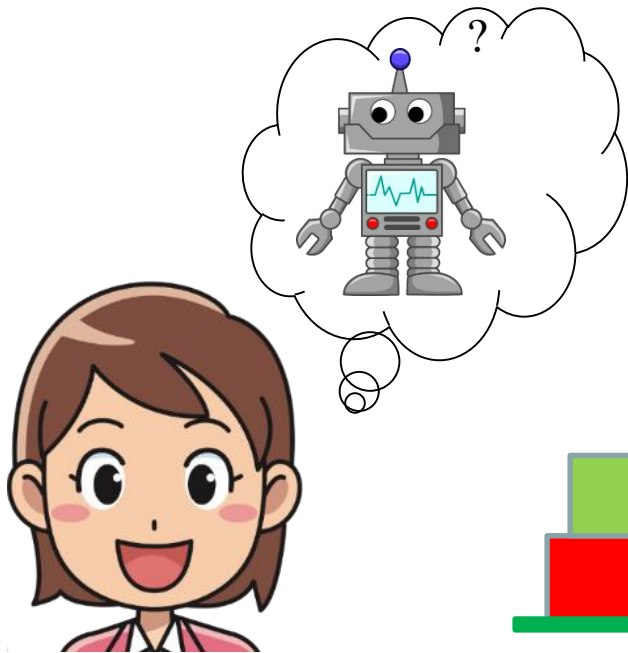
Characterization of Common Ground

- Perception
- Task knowledge
- Instantiated task components
 - Successes



Characterization of Common Ground

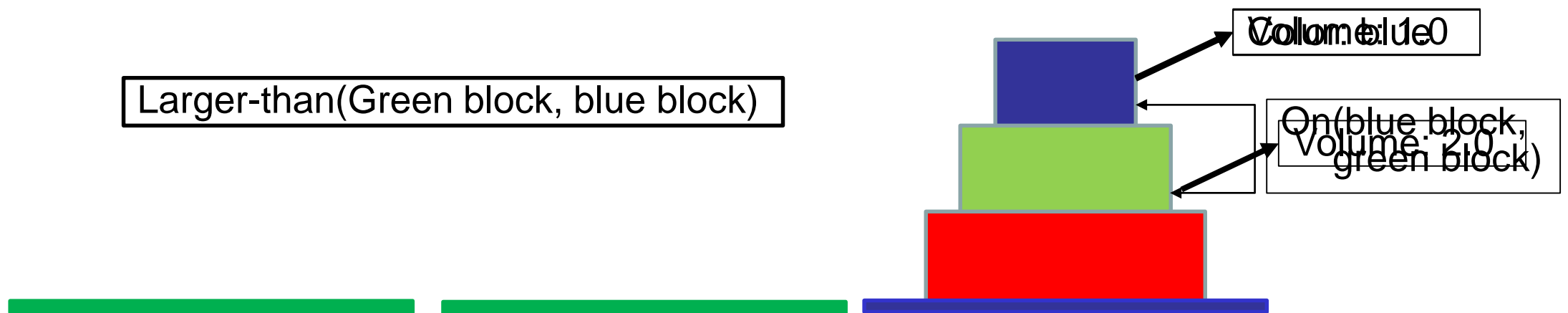
- Perception
- Task knowledge
- Instantiated task components
 - Successes *and failures*



Perception

- Rosie builds internal model of the environment
- Comprises
 - Objects, features, relations
 - Symbolic and metric information
 - Learned task concepts

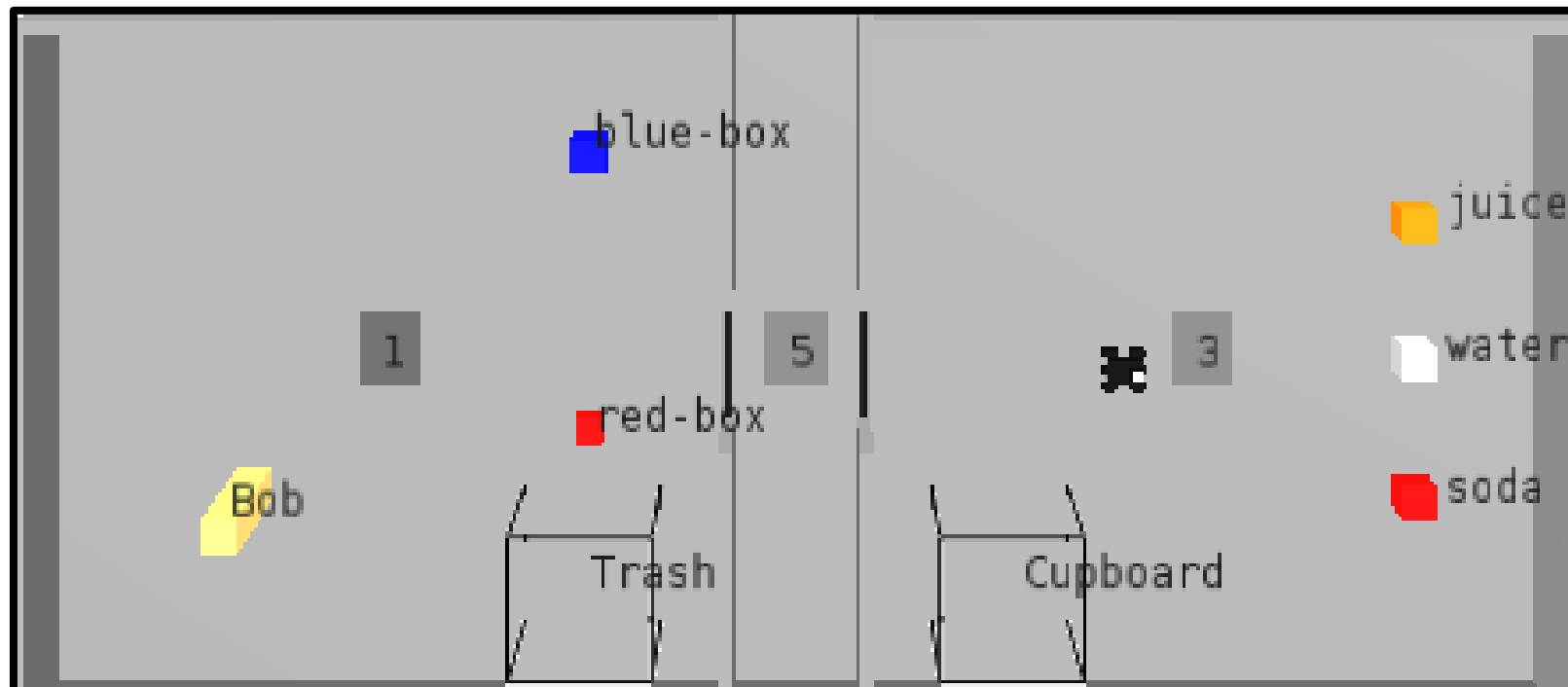
Ensures common understanding of environment



Perception

Mentor: What do you see?

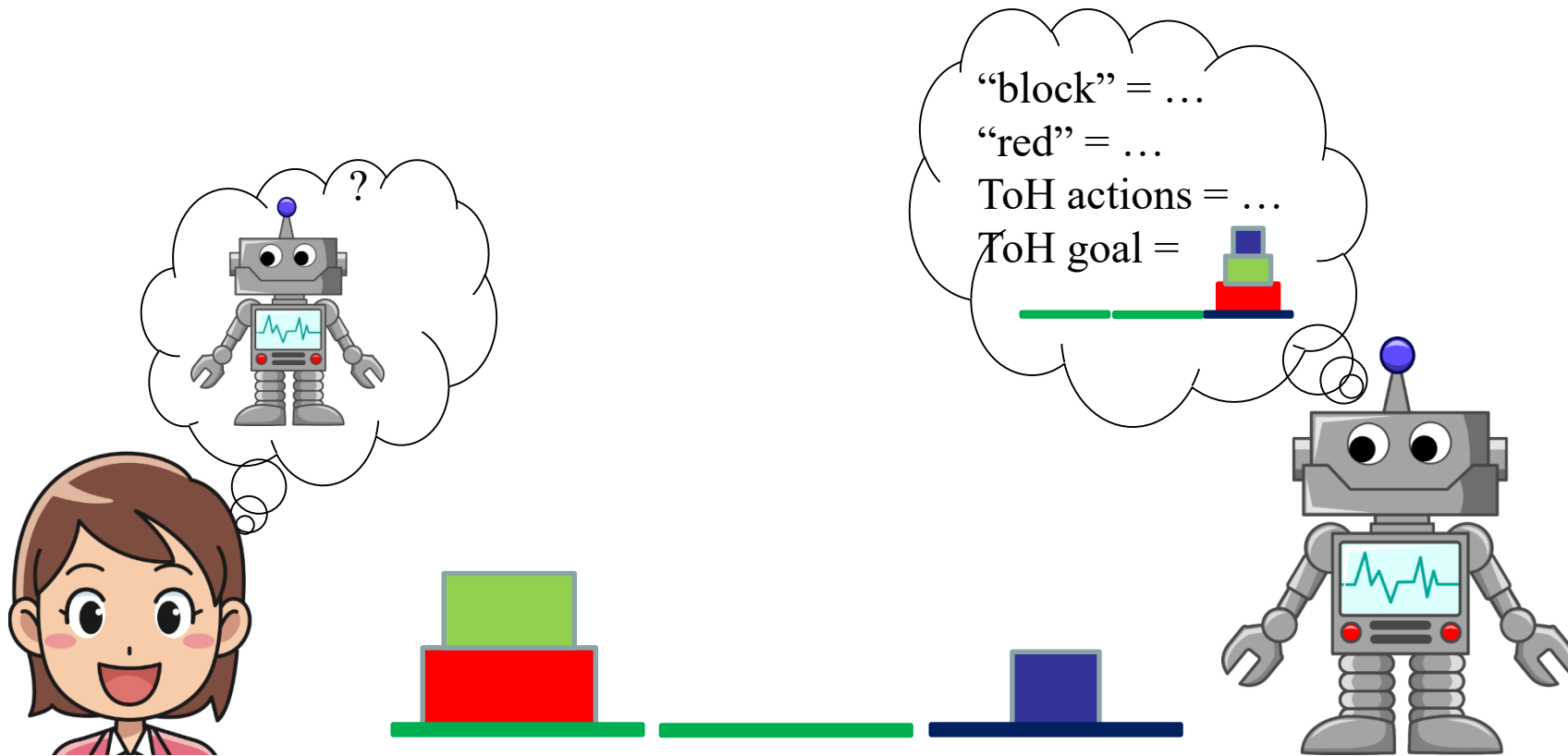
Rosie: “A white water, a cupboard, a red soda and an orange juice are in the kitchen location.”



Task Knowledge

- Rosie learns goals, actions, failure conditions, and concepts

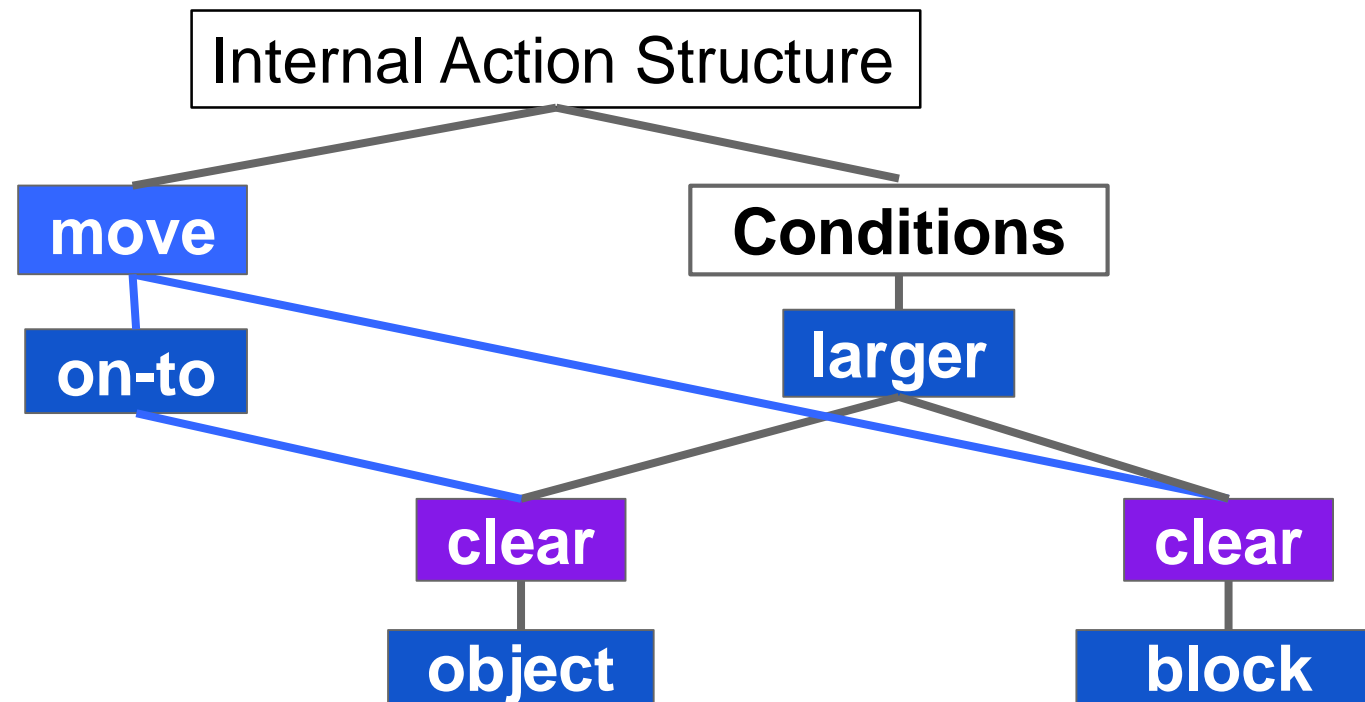
What does Rosie know about the task?



Task Knowledge

Mentor: “What is the action of Tower-of-Hanoi?”

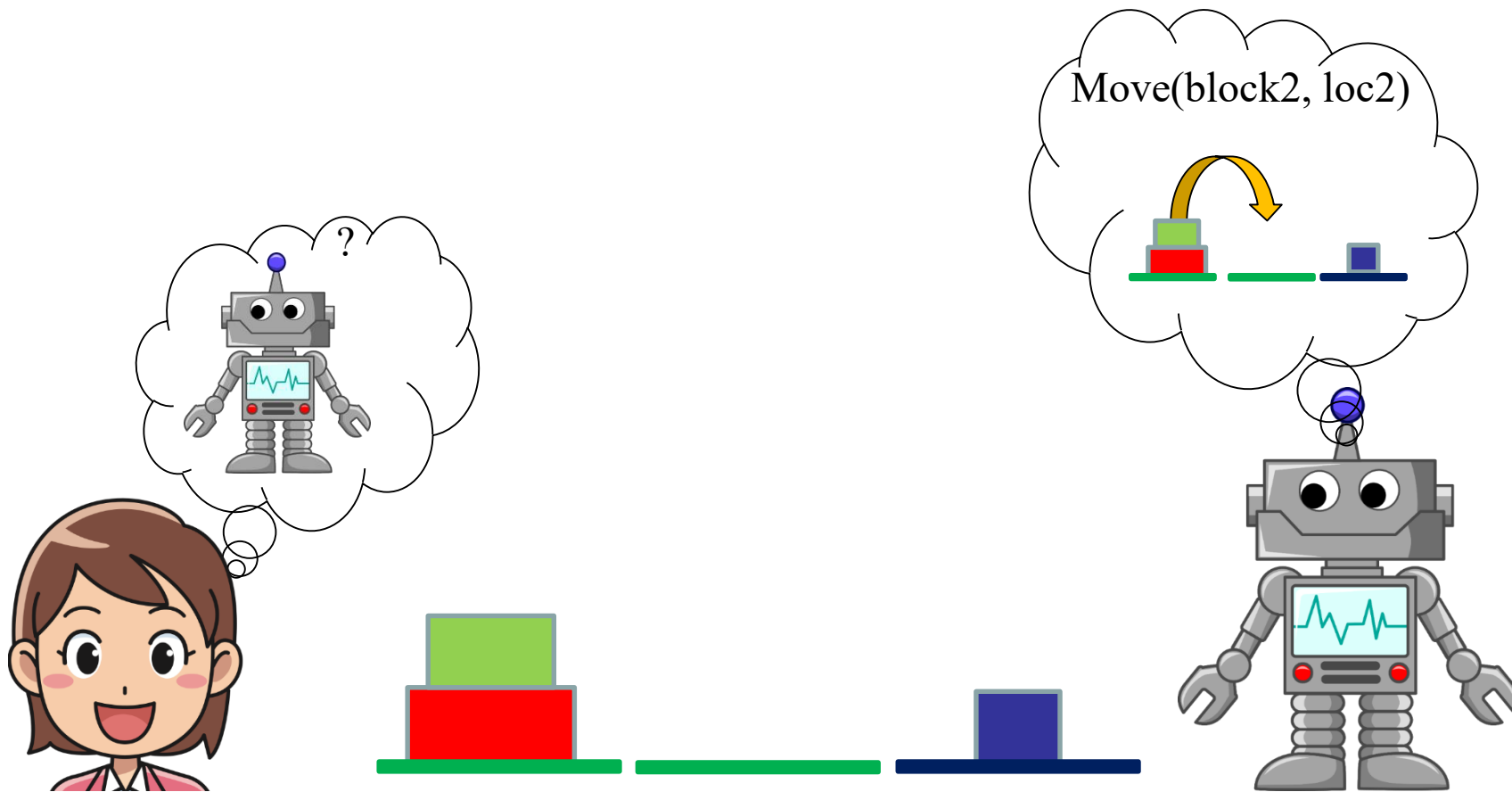
Rosie: “If a clear object is larger than a clear block, then move the clear block onto the clear object”



Instantiated Task Components

- Rosie applies task knowledge to its perception

What can Rosie do or detect right now?



Instantiating actions

Mentor: Which actions do you see?

Rosie: I see the following actions: pick-up the blue box, pick-up the trash and pick-up the red box

Mentor: Pick up the red box.

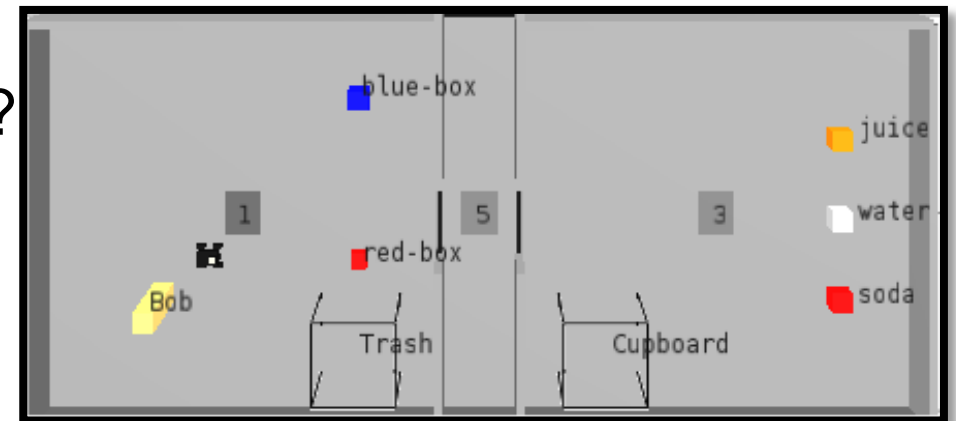
Rosie picks up red box

Mentor: Which actions do you see?

Rosie: I see the following actions: give the red box and put-down the red box

Mentor: Can you pick up the blue box?

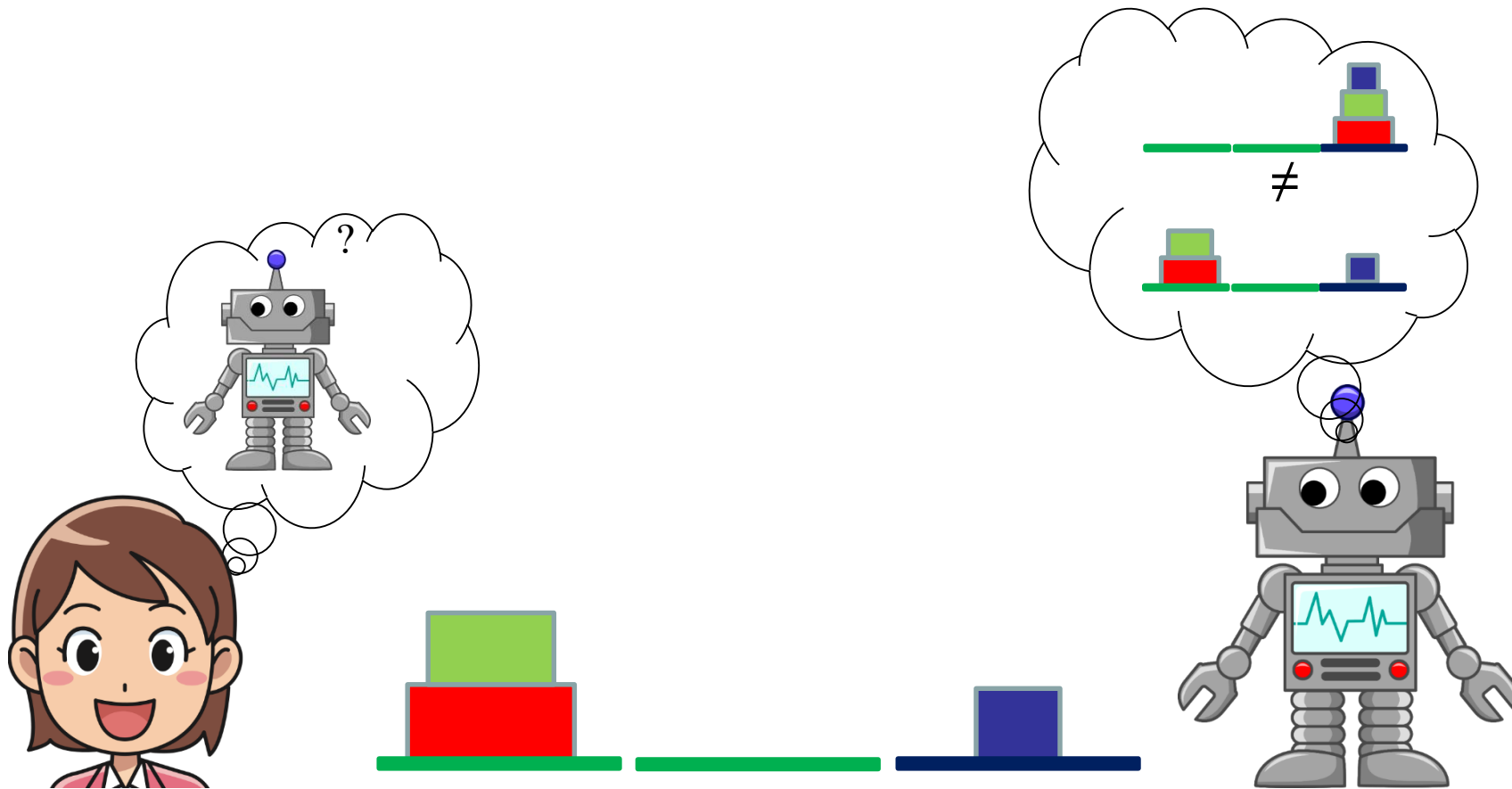
Rosie: No.



Instantiated Task Components - Failures

- Fails to detect specific task components

Why did Rosie fail?

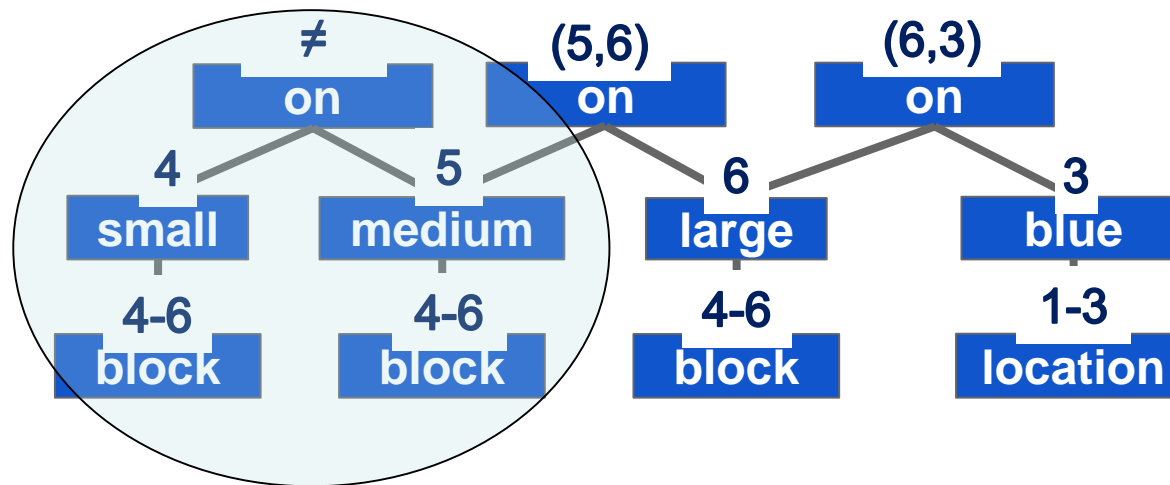


Failed Instantiation: Tower of Hanoi

Mentor: Do you see the goal of Tower-of-Hanoi?

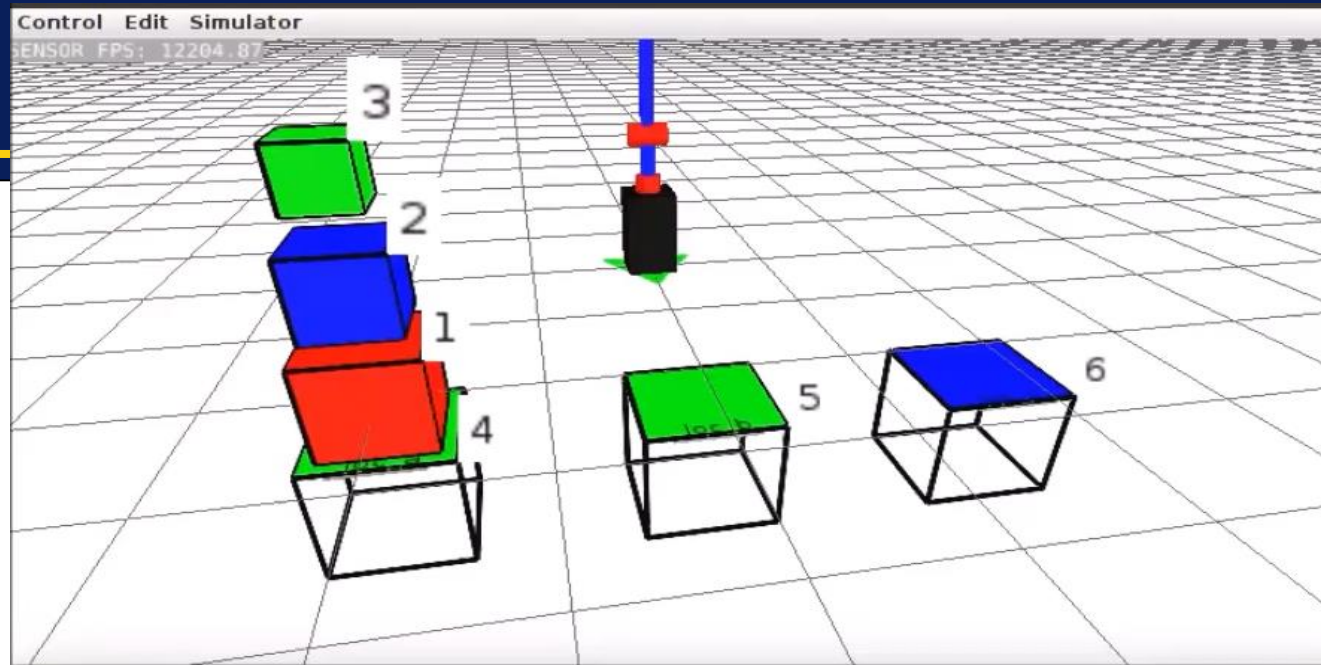
Rosie: No. A small block is not on a medium block.

Internal Goal Structure



Perception





The screenshot shows a 3D simulation environment with a grid floor. A robot arm with a black base and a blue vertical shaft is positioned in the center. To the left, a stack of four blocks is numbered 1 through 4 from bottom to top: a red block (1), a blue block (2), a blue block (3), and a green block (4). In the middle ground, there are two more blocks: a green block (5) and a blue block (6). The interface includes a menu bar at the top with 'Control Edit Simulator' and 'SENSOR FPS: 12204.87'. Below the 3D view is a 'Rosie Chat' window with a tabbed interface showing 'STOP Agent Environment Perception Action'. The chat window contains the text: '59:06:134 Agent: I am ready for a new task'. At the bottom right of the chat window is a green 'Send Message' button.

- Characterized knowledge important for common ground with ITL robot
- Implemented task-general question answering mechanisms
- Explore multi-modal transparency mechanisms

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