Learning and Teaching Task Specifications from Demonstrations

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Motivation

- How do we design interfaces and control for Human-CPS to joint problem-solve with people?
- How can work in Cognitive Science help with designing systems that can share representations with humans?
- What types of mechanisms are needed for effective communication and collaboration?

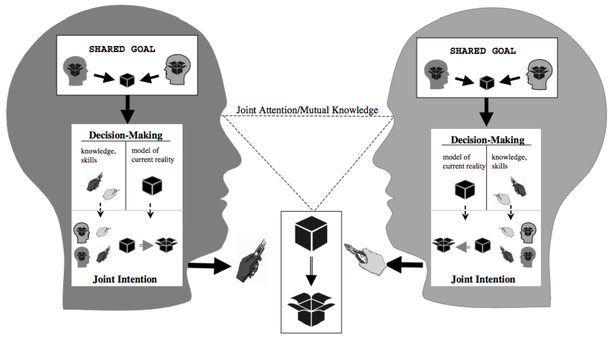
Joint Problem Solving Representations

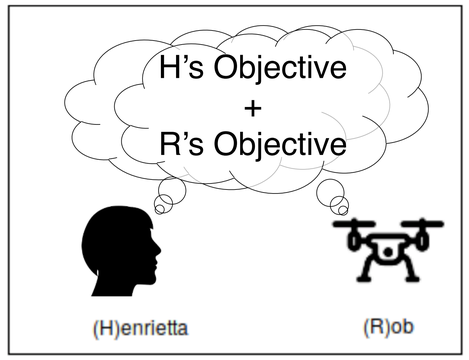
A shared representational format should be:

- Composable
- Resilient to changes in task environment
- Learnable
- Communicatable

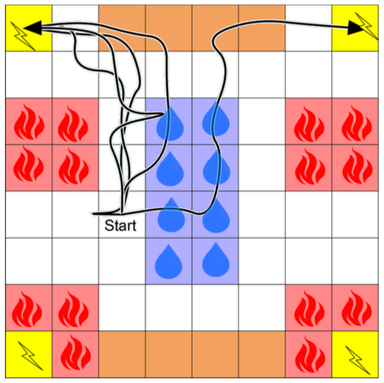
- Reward functions are typically used but have problems (e.g. no “common currency”)
- We propose Boolean specifications since they compose well and can express non-Markov tasks
- This work develops tools for learning and teaching task specifications from demonstrations

Shared Representations





Specification Inference Problem



Robot in a gridworld task with three constraints:

1. If water (blue) is entered, eventually go to a drying tile (brown).
2. Eventually recharge (yellow).
3. Avoid fire (red).

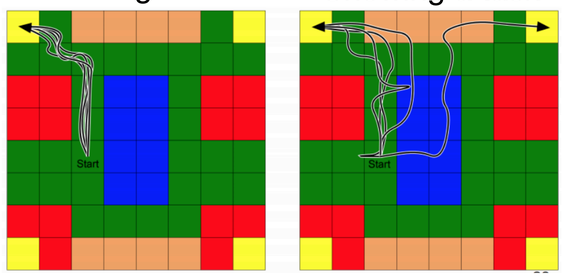
$$P(\varphi \mid \zeta_{0:N}) \propto e^{N D_{\mathrm{KL}}(\mathcal{B}(\bar{\varphi}) || \mathcal{B}(\hat{\varphi}))}$$

Specification | Demonstrations

# of Demonstrations; Bernoulli Distribution; Distance b/t Distributions; Teacher Demonstration Satisfaction Rate; Random Satisfaction Rate

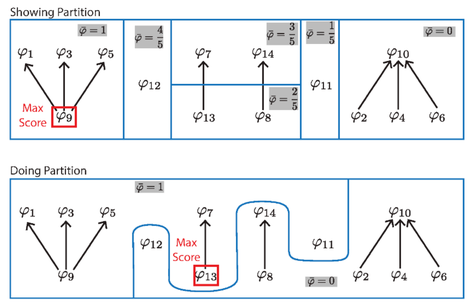
Specification Communication Problem

Doing a task | Showing a task



$$D_{KL}\left(\mathcal{B}(\overline{\varphi}) \parallel \mathcal{B}(\widehat{\varphi})\right)$$

Likelihood entirely determined by partitioning of concept class.



References
Vazquez-Chanlatte et al. Learning Task Specifications from Demonstrations. NIPS 2018.
Vazquez-Chanlatte et al. Communicating Compositional and Temporal Specifications by Demonstration. CPHS 2018

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