Viewpoint-Conditioned Legible Motion Planning with Imitation and Reinforcement Learning

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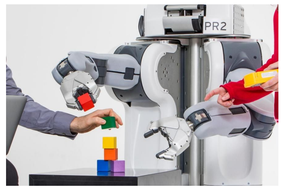
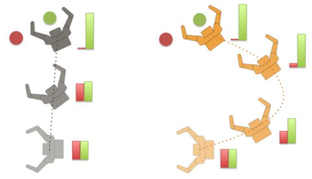
Legible motion planning: the key to effective human-robot collaboration

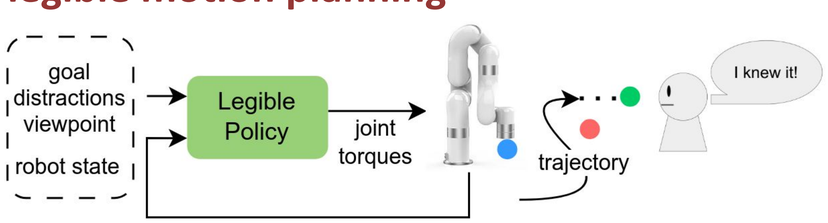


Legible motion is crucial for efficiency and trust in assistive robotics and cooperative tasks

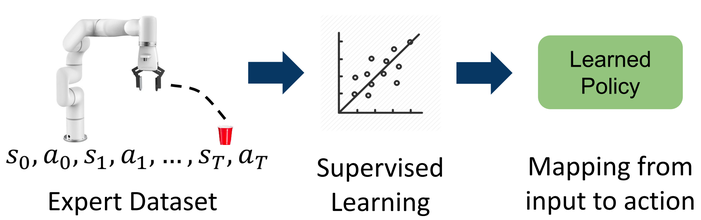
Robots that behave in an understandable manner boost human experience



A unified system for learning-based legible motion planning

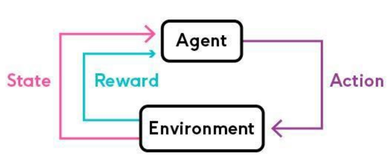


IL performs supervised learning on legible expert demonstrations



Expert Dataset — Supervised Learning — Mapping from input to action

RL maximizes a legibility reward by interacting with the environment



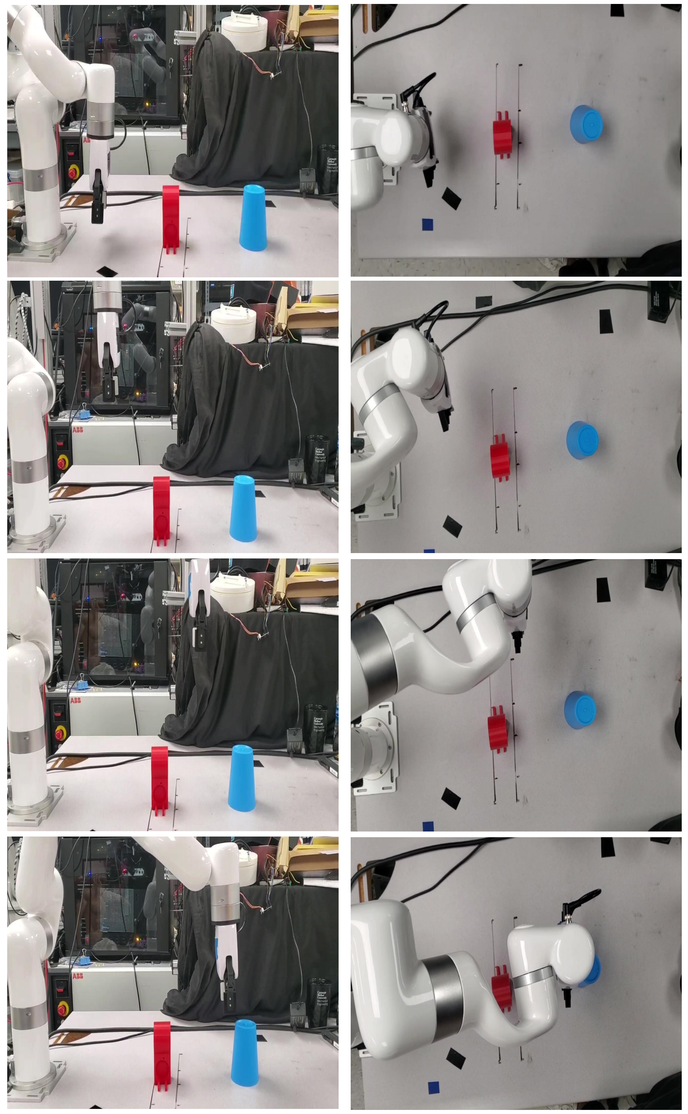
Algorithm:
soft actor-critic + hindsight exp. replay

Reward:

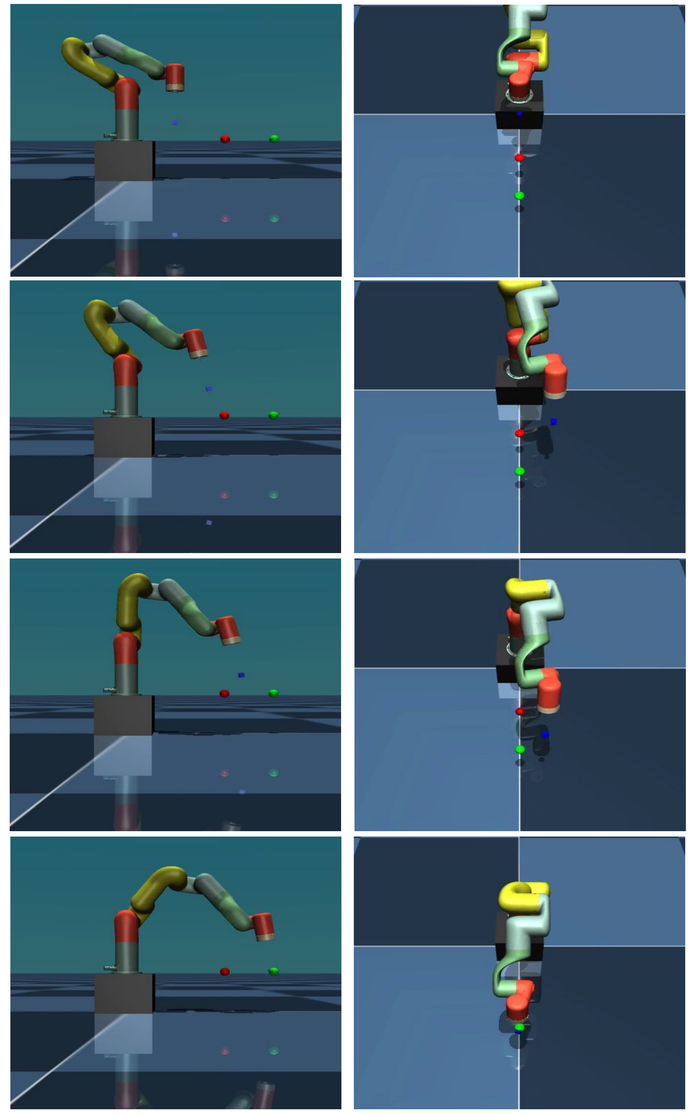
$$r = -\alpha_1 d_{\text{goal}} + \alpha_2 g(d_{\text{distract}}, \beta_1) - \alpha_3 e_{\text{rot}} + \alpha_4 g(z, \beta_2)$$

$$g(x, y) = -1 \text{ if } x \leq y, \text{ otherwise } 0$$

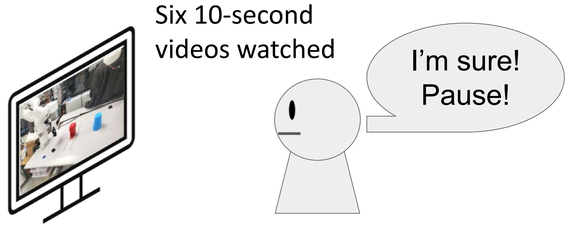
Results of Imitation Learning Policy



Results of Reinforcement Learning Policy



We asked our friends for evaluation



Expert	0.65
IM policy	0.64
RL policy	0.75

$$\text{correct} \cdot \left(1 - \frac{t_{\text{pause}}}{t_{\text{total}}}\right)$$

Conclusions and Future Work

✅ Accomplished goal-oriented tasks with legible motion plans considering observer's viewpoint

✅ Evaluated two learning-based methods with humans and compared with expert baseline

🦾 Future Work: Integrate multi-modal sensory inputs for adaptive and dynamic legible motion

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