LLM-Guided State Estimation for Partially Observable Task and Motion Planning

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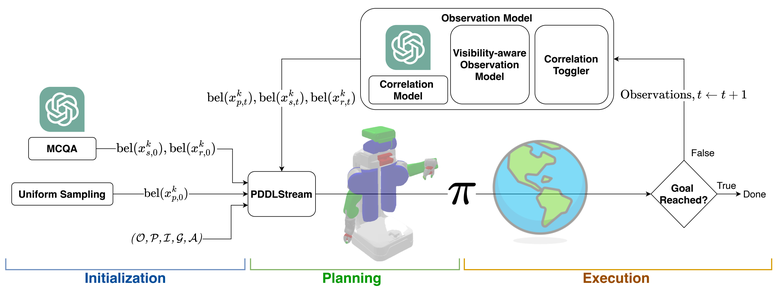
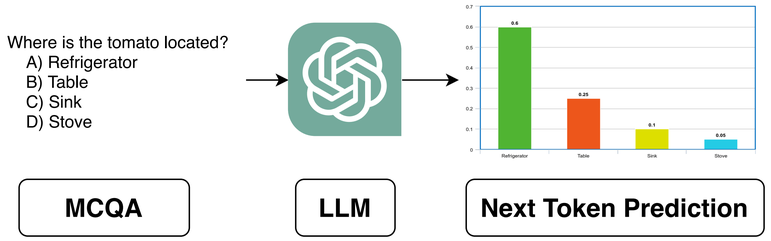
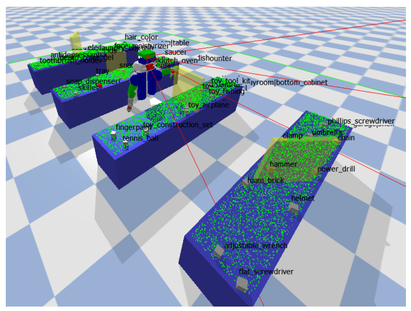
CoCo-TAMP is a planning-and-execution framework that leverages LLM derived common-sense priors and co-location cues to shape beliefs under partial observability.

Overview



Initialization





Planning

Off-the-shelf TAMP planner solves a determinized partially observable TAMP problem.

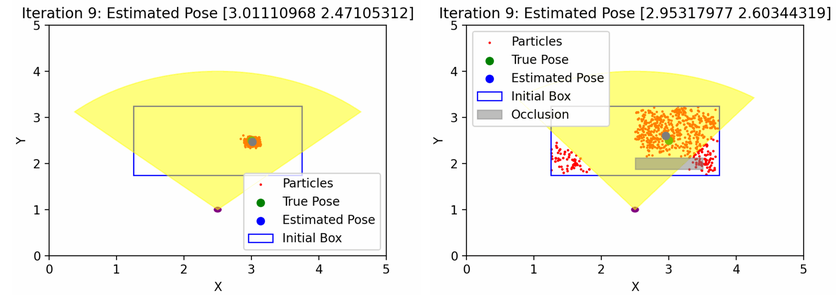
$$V^*(s) = min_{a \in A(s)} [Q^*(s,a)]$$
$$= min_{a \in A(s)} \left[\frac{cost(a)}{p(s'|s,a)} + V^*(s') \right]$$

Execution

$$P(x^j_{r,t} \mid x^k_{r,t}) = \begin{cases} \texttt{sim}(j,k)\,\delta_{jk} + (1 - \texttt{sim}(j,k))\,u_{jk}, \texttt{sim}(j,k) \geq 0, \\ \texttt{abs}(\texttt{sim}(j,k))\bar{\delta}_{jk} + (1 + \texttt{sim}(j,k))\,u_{jk}, \texttt{sim}(j,k) \leq 0. \end{cases}$$

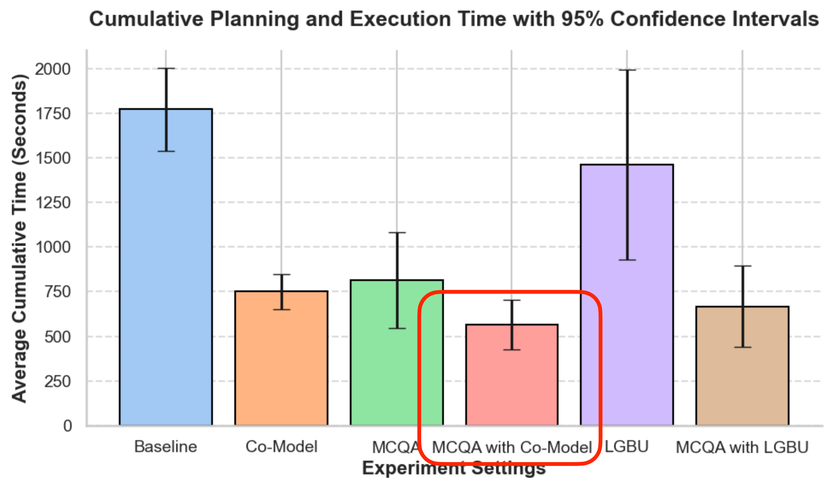
Visibility-aware Observation Model

$$\begin{aligned} \text{bel}(x^k_{p,t}) &= P(x^k_{p,t} \mid x^k_{s,t}, x^k_{r,t} z^k_{p,t}), \\ &= \eta P(z^k_{p,t} \mid x^k_{p,t}, x^k_{s,t}, x^k_{r,t}) \overline{\text{bel}}(x_p(t)), \text{ or} \\ &= \eta P(\overline{z^k_{p,t}} \mid x^k_{p,t}, x^k_{s,t}, x^k_{r,t}) \overline{\text{bel}}(x_p(t)) . \end{aligned}$$



Results

Without Occlusion | Occlusion



Project Website

TEXAS The University of Texas at Austin

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