

## Motivation: Endowing Agents with Interactivity

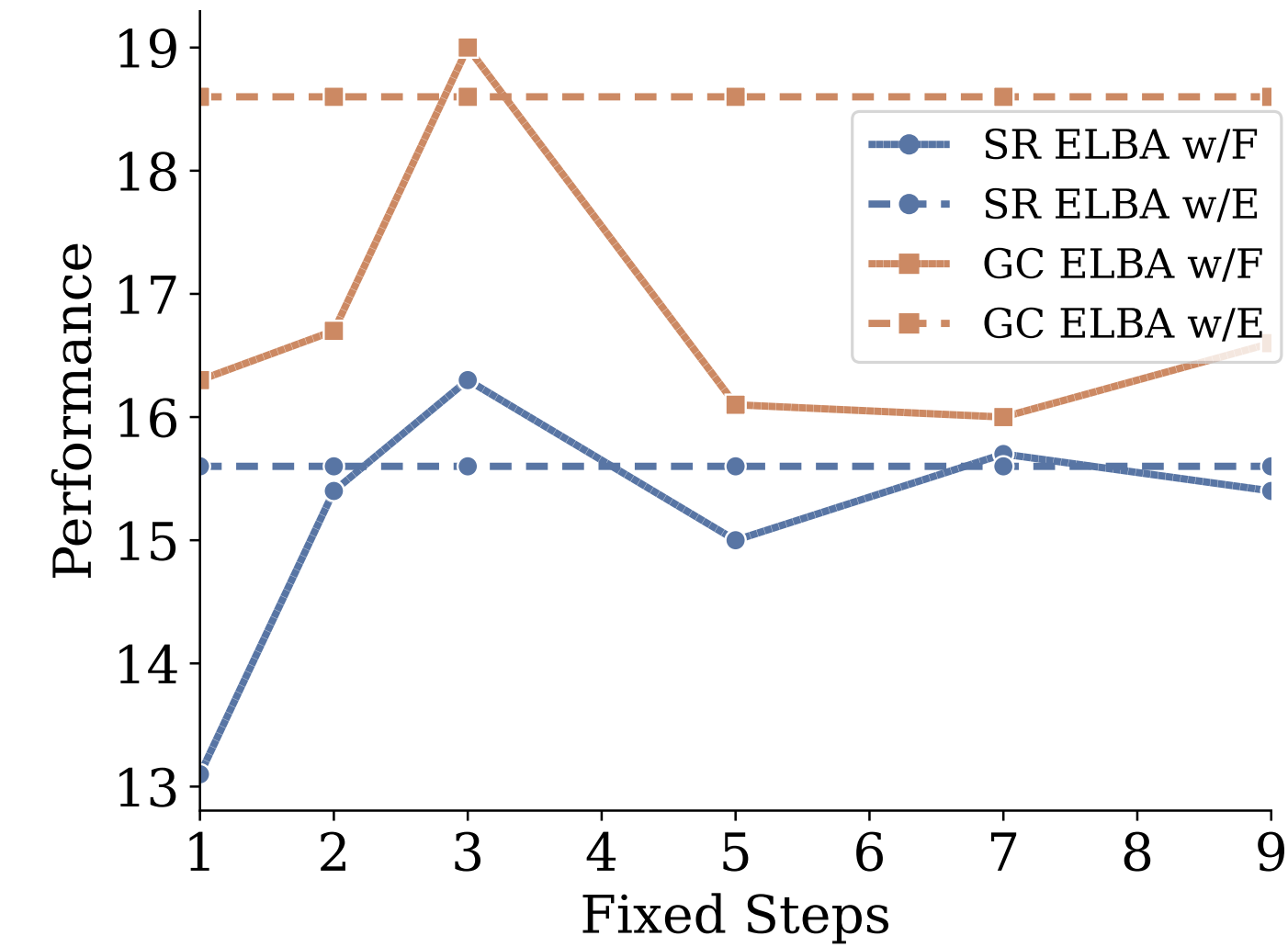
To effectively assist humans, embodied agents must not only understand instructions but also be able to actively seek feedback during task execution.

Human-agent interaction enables the agent to ask for clarifications, correct plans, and adjust to human preferences by asking questions.

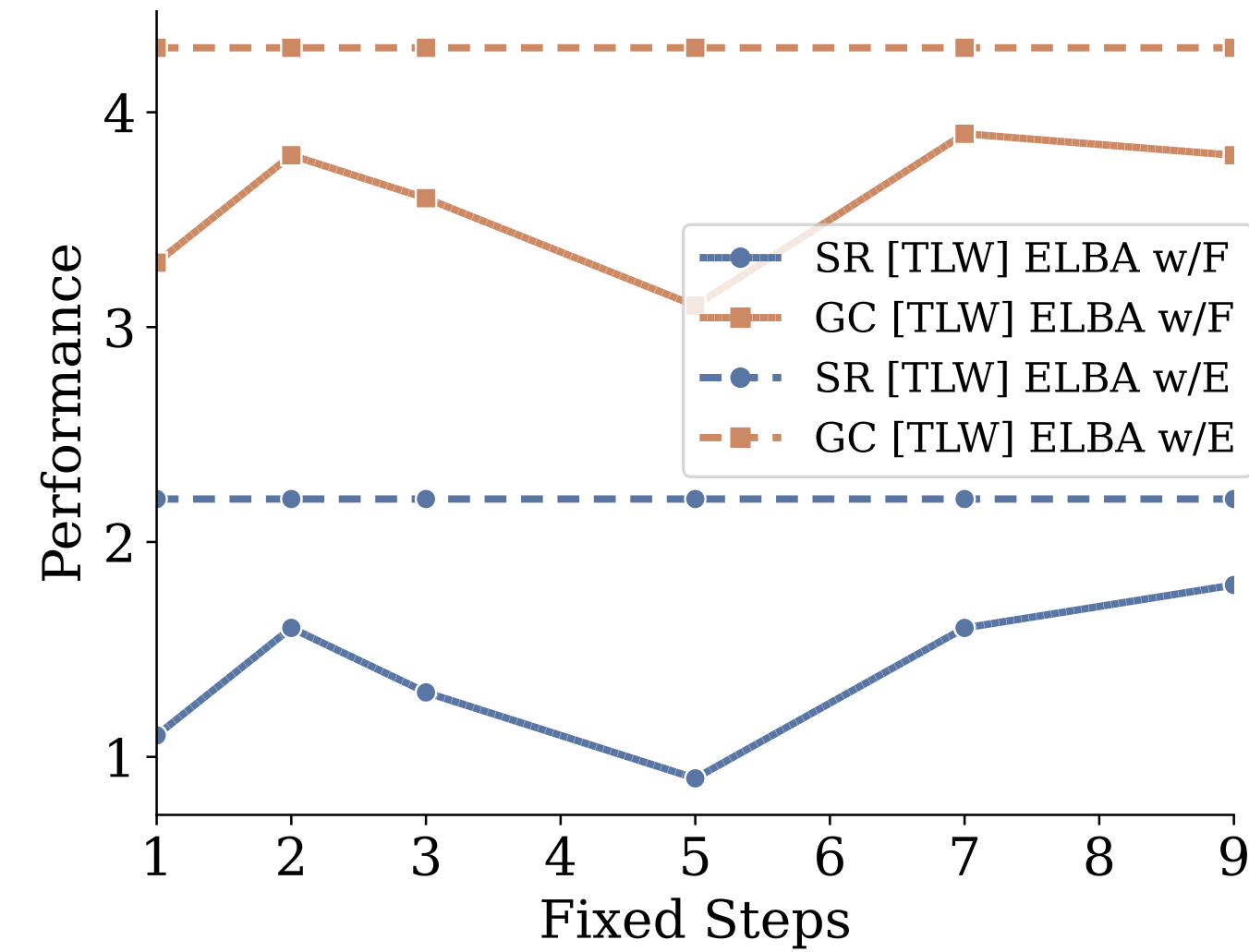
🔥 In this work, we introduce **ELBA**, an Embodied Learning By Asking model that learns *when* and *what* questions to ask to improve task completion.

## Analysis of Asked Questions

- ELBA, which enables embodied agents to ask questions when confused, outperforms baselines that ask questions at fixed time steps.

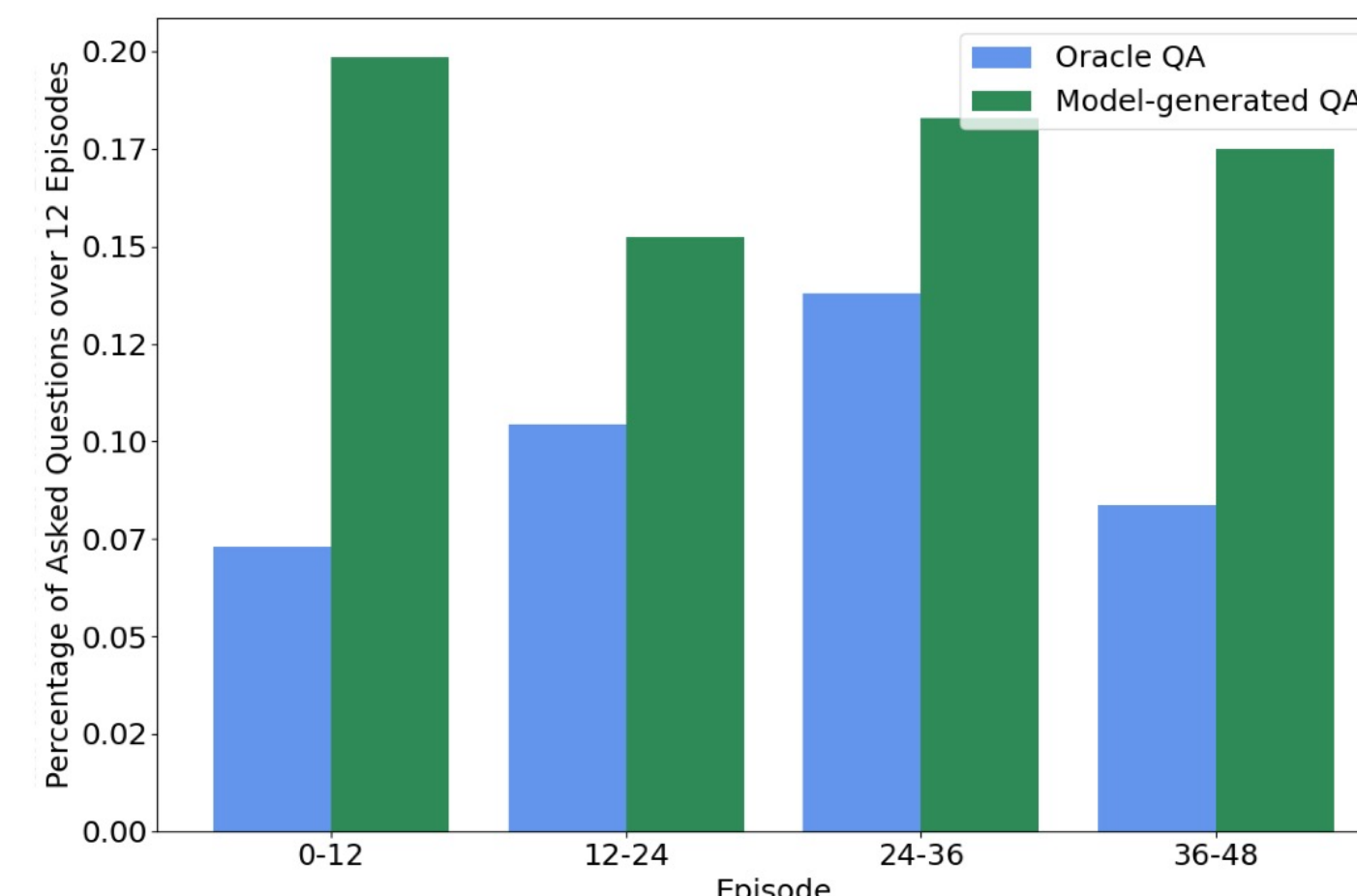


(a) ELBA w/E - SR and GC

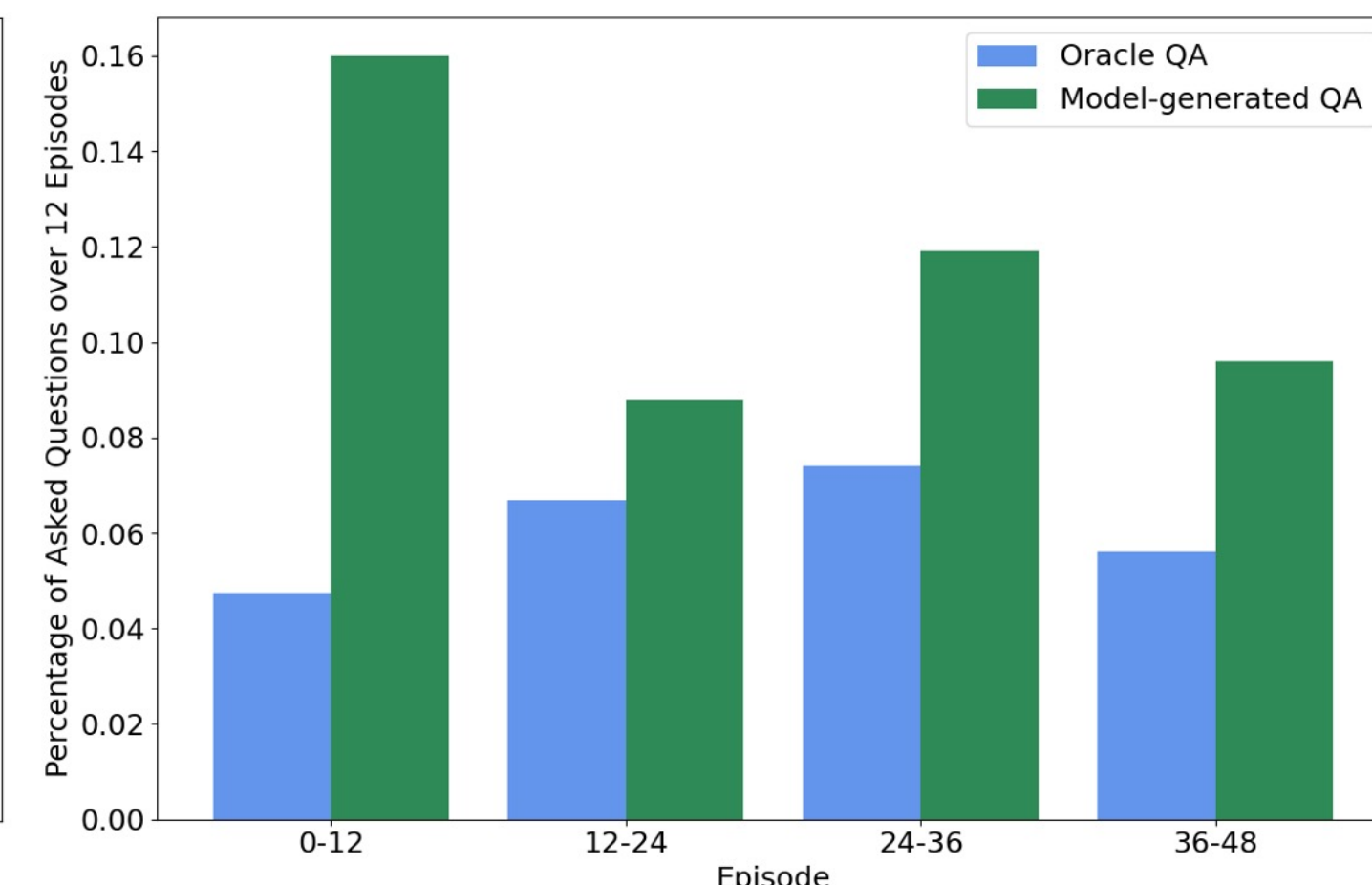


(b) ELBA w/E - SR[TLW] and GC[TLW]

- ELBA allows the agents to ask both oracle and model-generated free-form questions.

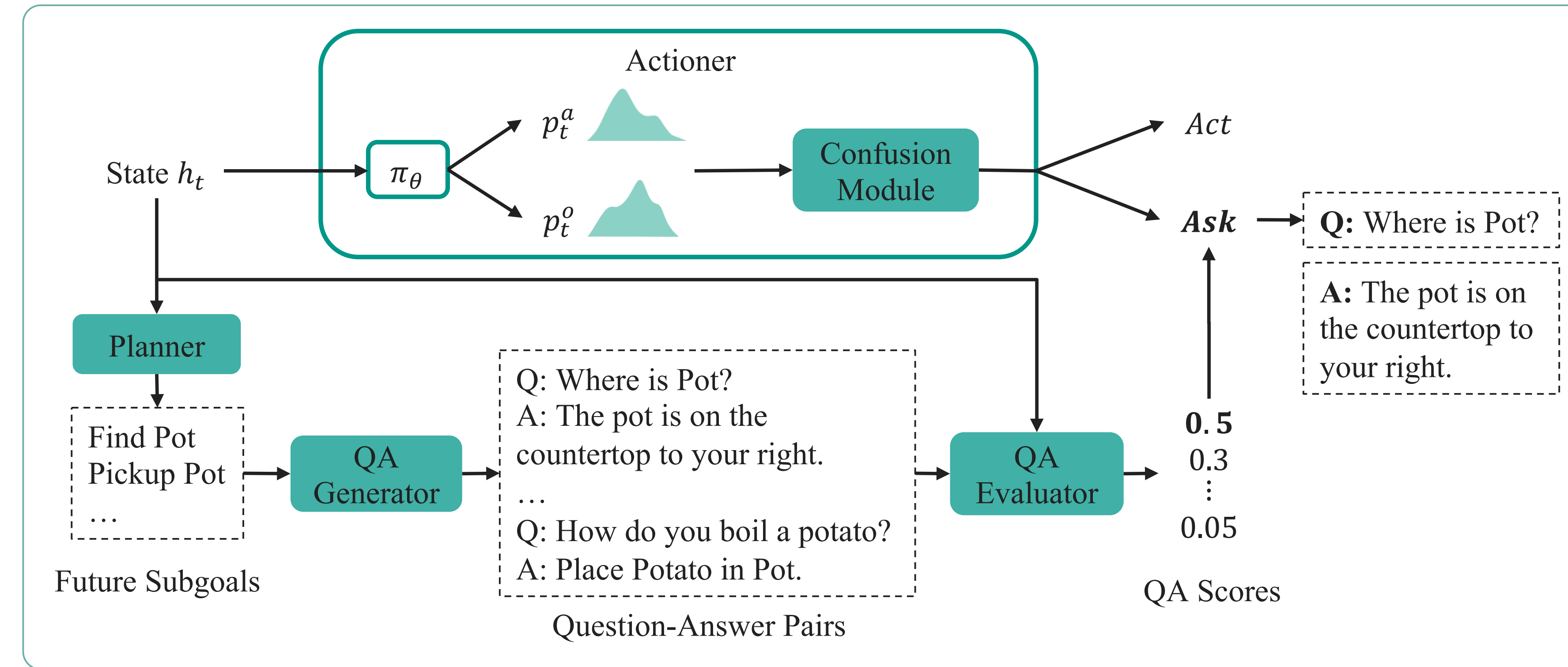


(a) ELBA w/E



(a) ELBA w/G

## Embodied Learning By Asking



**Confusion Module** determines the agent's confusion level by measuring either the **entropy** of the predicted distribution or the **gradient** magnitude of the model. When the confusion level exceeds a certain threshold, the agent generates a set of candidate questions.

- Entropy-based Confusion:

$$(H(p_t^a) > \epsilon_a) \quad \text{or} \quad (H(p_t^o) > \epsilon_o \quad \text{and} \quad \hat{\alpha}_t \in \mathcal{A}^I) \quad (1)$$

- Gradient-based Confusion:

$$g_t = \nabla_{h_{t-1}} (\mathcal{L}(f_a(h_{t-1}), \hat{\alpha}_t) + \mathcal{L}(f_o(h_{t-1}), \hat{o}_t)), \quad \|g_t\|_2 > \epsilon \quad (2)$$

## Task and Goal-Condition Success

ELBA outperforms the baseline E.T. model that lacks QA capabilities.

Model	Seen		Unseen	
	SR [TLW]	GC [TLW]	SR [TLW]	GC [TLW]
Baseline (E.T.)	15.1 [2.3]	15.7 [4.0]	4.9 [0.2]	3.3 [0.8]
ELBA w/E	<b>15.8</b> [1.6]	<b>19.2</b> [4.1]	<b>5.7</b> [0.5]	<b>3.8</b> [1.1]
ELBA w/G	15.4 [1.8]	18.4 [3.9]	5.1 [0.2]	3.8 [1.1]

## Qualitative Results

By posing relevant questions, ELBA navigates and manipulates objects correctly. E.T. may struggle to predict the correct object.



Qualitative examples of predicted trajectories of E.T. and ELBA. Examples (a) and (b) show the successful cases of ELBA, while (c), (d), and (e) show failure cases.

## Paper

Please check out our paper for more details!

