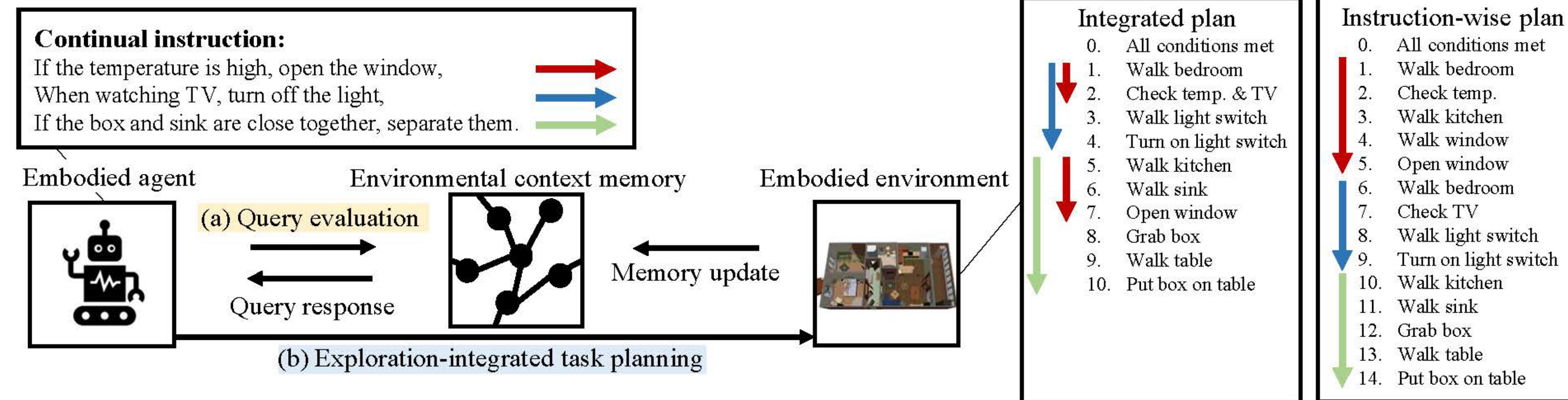


# Exploratory Retrieval-Augmented Planning For Continual Embodied Instruction Following

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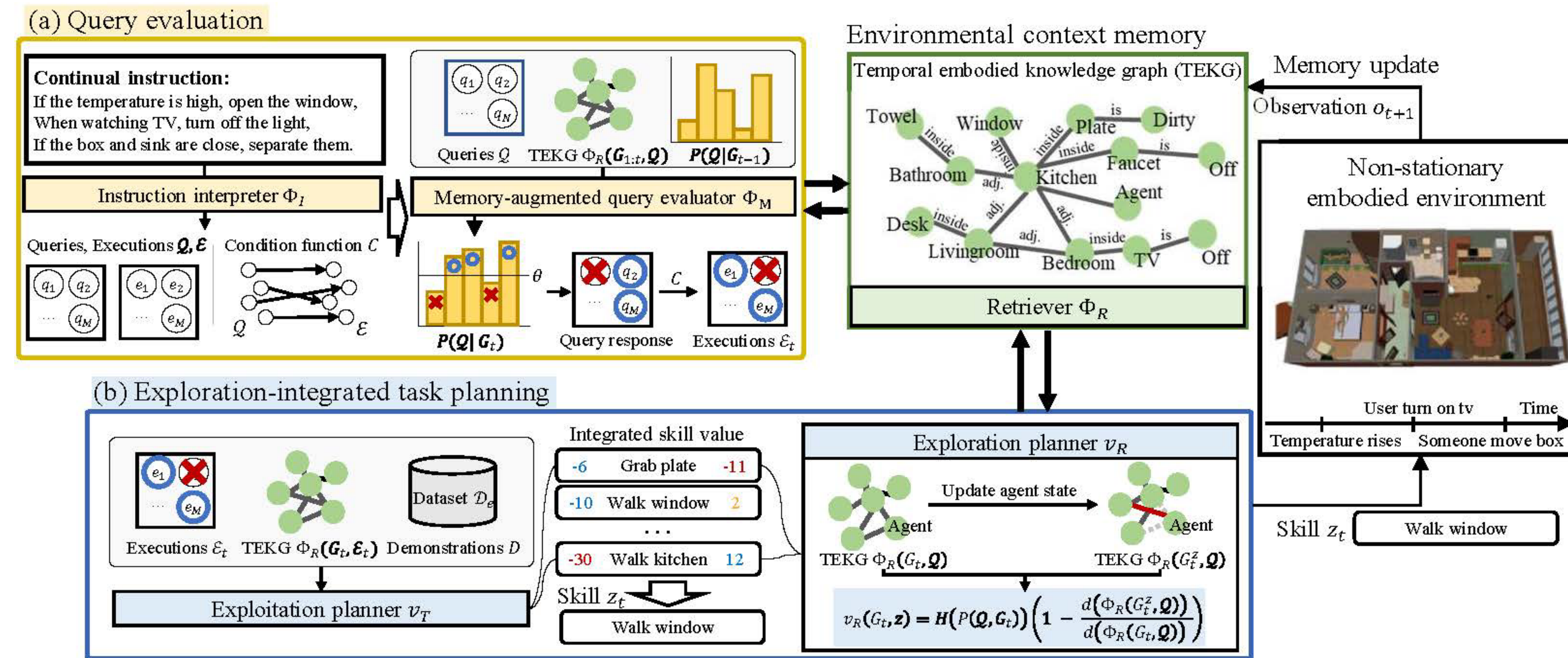
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## Continual instruction following



- Embodied tasks are **conditioned** on contexts and conducted **continuously**, as **continual instruction following**,
- We propose a novel **ExRAP framework**, combining LLMs' reasoning capabilities and environmental context memory into **integrated task planning** to address continuous instruction following tasks in **non-stationary embodied environments**.

## Exploratory Retrieval-Augmented Planning (ExRAP)



- In (a), a **Temporal Embodied Knowledge Graph** creates the environmental context memory, and query response refined by information-based **temporal consistency** to handle uncertainties caused by outdated data.
- In (b), ExRAP plans skills that balance task achievement and confidence in query evaluations (**Exploration**) based on information estimation.

## Experiments

Test Environment: VirtualHome, ALFRED, CARLA



Model	Low non-stationarity		Medium non-stationarity		High non-stationarity	
	SR ( $\uparrow$ )	PS ( $\downarrow$ )	SR ( $\uparrow$ )	PS ( $\downarrow$ )	SR ( $\uparrow$ )	PS ( $\downarrow$ )
<b>Evaluation in VirtualHome</b>						
ZSP	20.59% $\pm$ 4.71%	31.03 $\pm$ 4.68	20.06% $\pm$ 1.93%	32.06 $\pm$ 4.66	17.28% $\pm$ 3.16%	24.08 $\pm$ 4.63
SayCan	35.12% $\pm$ 4.83%	21.67 $\pm$ 3.81	33.69% $\pm$ 5.36%	21.81 $\pm$ 4.14	27.33% $\pm$ 4.24%	16.18 $\pm$ 3.98
ProgPrompt	32.10% $\pm$ 4.41%	18.84 $\pm$ 4.08	30.51% $\pm$ 5.31%	23.43 $\pm$ 1.07	27.19% $\pm$ 2.99%	18.60 $\pm$ 4.22
LLM-Planner	40.97% $\pm$ 7.00%	17.61 $\pm$ 1.40	39.89% $\pm$ 4.52%	15.93 $\pm$ 2.13	34.60% $\pm$ 6.49%	14.94 $\pm$ 2.89
ExRAP	<b>61.12%<math>\pm</math>7.03%</b>	<b>11.75<math>\pm</math>2.49</b>	<b>55.14%<math>\pm</math>6.59%</b>	<b>11.33<math>\pm</math>1.92</b>	<b>50.12%<math>\pm</math>5.70%</b>	<b>8.61<math>\pm</math>2.25</b>
<b>Evaluation in ALFRED</b>						
ZSP	18.22% $\pm$ 5.33%	17.24 $\pm$ 2.12	14.67% $\pm$ 6.18%	20.83 $\pm$ 3.63	9.56% $\pm$ 4.80%	22.53 $\pm$ 3.57
SayCan	45.67% $\pm$ 6.89%	8.25 $\pm$ 1.86	41.81% $\pm$ 7.64%	8.39 $\pm$ 3.55	35.79% $\pm$ 6.31%	7.42 $\pm$ 1.14
ProgPrompt	47.15% $\pm$ 1.17%	9.81 $\pm$ 2.14	35.62% $\pm$ 1.04%	7.22 $\pm$ 1.35	19.97% $\pm$ 0.80%	7.52 $\pm$ 2.45
LLM-Planner	58.44% $\pm$ 3.97%	7.28 $\pm$ 1.09	51.80% $\pm$ 3.79%	7.28 $\pm$ 1.05	35.76% $\pm$ 6.00%	6.65 $\pm$ 1.06
ExRAP	<b>69.90%<math>\pm</math>1.47%</b>	<b>5.94<math>\pm</math>0.92</b>	<b>64.00%<math>\pm</math>5.07%</b>	<b>4.82<math>\pm</math>1.03</b>	<b>59.11%<math>\pm</math>2.48%</b>	<b>4.42<math>\pm</math>1.36</b>
<b>Evaluation in CALRA</b>						
ZSP	10.44% $\pm$ 1.03%	29.35 $\pm$ 7.21	6.89% $\pm$ 2.98%	32.46 $\pm$ 6.03	4.67% $\pm$ 1.17%	33.00 $\pm$ 1.40
SayCan	37.55% $\pm$ 4.74%	20.73 $\pm$ 5.36	35.11% $\pm$ 6.12%	22.44 $\pm$ 5.38	30.71% $\pm$ 5.28%	21.71 $\pm$ 2.01
LLM-Planner	50.83% $\pm$ 1.60%	14.02 $\pm$ 3.01	44.00% $\pm$ 0.70%	14.39 $\pm$ 1.94	41.58% $\pm$ 3.35%	13.59 $\pm$ 2.65
ExRAP	<b>65.25%<math>\pm</math>7.47%</b>	<b>12.43<math>\pm</math>3.90</b>	<b>62.25%<math>\pm</math>6.72%</b>	<b>11.50<math>\pm</math>2.24</b>	<b>58.83%<math>\pm</math>10.08%</b>	<b>10.84<math>\pm</math>2.52</b>

- ExRAP** consistently **outperforms** other models in terms of **Task Success Rate (SR)** across varying levels of non-stationarity and diverse environments, attributed to the advantages of **retrieval-augmented planning**.
- ExRAP** achieves a **lower Pending Steps (PS)** compared to other models, especially in medium and high non-stationarity scenarios, due to its **efficient exploration-integrated planning**.

