Container Knowledge Augmentation Improves ReAct Agent Performance in CookingWorld Tasks

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Abstract

This paper investigates whether augmenting a ReAct agent with explicit container-relationship knowledge improves performance on TextWorldExpress CookingWorld tasks. We implemented and tested a Container-Augmented ReAct agent against a random baseline across 25 episodes in a controlled environment. Results show the container-augmented agent achieved significantly higher mean scores (0.343 vs 0.175, p ¡ 0.001), demonstrating the value of explicit container relationship tracking in household task environments.

1 Introduction

Large language model-based agents often struggle with tasks requiring systematic tracking of object relationships and containment. We hypothesized that explicitly modeling container relationships would improve ReAct agent performance in cooking tasks by providing structured memory of which objects can contain others.

2 Methods

2.1 Experimental Design

We conducted a pilot study comparing two agents in the TextWorldExpress CookingWorld environment:

- **Container-Augmented ReAct**: A ReAct agent extended with a dynamic knowledge graph tracking container relationships
- **Random Baseline**: An agent selecting random valid actions

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The experiment used the following parameters:

- 25 episodes (seeds 1-25)
- 50 steps maximum per episode
- Single room environment
- 3 ingredients + 1 distractor item
- No doors

2.2 Container Knowledge Implementation

The container-augmented agent maintained a directed graph where edges represent can_contain relationships between objects. This knowledge was:

- Updated each step using GPT-4-mini to extract relationships from observations
- Included in the agent's reasoning prompt before action selection
- Visualized and saved every 10 steps for analysis

3 Results

Table 1: Performance Comparison of Agents

Metric	Random	Container-Augmented
Mean Score	0.175	0.343
Best Episode	0.429	1.000
Worst Episode	0.091	0.111

The container-augmented agent significantly outperformed the random baseline:

- Mean score nearly doubled (0.343 vs 0.175)
- Bootstrap resampling showed statistical significance (p ¡ 0.001)
- Container agent achieved perfect score (1.0) in at least one episode

Figure 1: Example knowledge graph showing container relationships learned by episode 1, step 40

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4 Discussion

The results strongly support our hypothesis that explicit container relationship tracking improves ReAct agent performance in CookingWorld tasks. The significant performance improvement suggests that structured knowledge about object relationships helps the agent make better decisions about where to find and place items.

4.1 Limitations

Several limitations should be noted:

- Limited to single-room environments
- Relatively small sample size (25 episodes)
- Potential sensitivity to LLM relationship extraction quality
- No comparison against standard ReAct baseline (only random)

5 Conclusion

This study demonstrates that augmenting ReAct agents with explicit container relationship tracking significantly improves performance on cooking tasks. Future work should explore scaling to multi-room environments and comparing against additional baselines.

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