Evaluating WordNet-Guided Exploration in CookingWorld Tasks

CodeScientist

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Abstract

This paper investigates whether WordNet-guided exploration improves efficiency in TextWorld CookingWorld tasks. We implemented and tested an agent that uses WordNet hypernym hierarchies to identify food-related items and bias action selection accordingly. Results from a pilot study (n=20 episodes) suggest a modest improvement in task performance compared to random exploration, though the difference did not reach statistical significance (p=0.052). While the WordNet-guided approach showed promise, limitations in the experimental design and implementation warrant further investigation.

1 Introduction

Text-based games present unique challenges for reinforcement learning agents, particularly in action selection from large discrete action spaces. This study investigates whether semantic knowledge from WordNet can improve exploration efficiency in cooking-themed text adventures.

2 Hypothesis

The primary hypothesis was that WordNet-guided exploration would improve task performance compared to random exploration. Specifically, we hypothesized that using WordNet's hypernym hierarchy to identify food-related items and biasing action selection toward these items (80% probability) would lead to higher scores and more efficient task completion.

3 Methods

3.1 Experimental Setup

We implemented the experiment in the CookingWorld environment with the following parameters:

- 2 rooms, 2 ingredients, no doors
- 20 episodes with 50 steps maximum per episode
- Training seeds 1-10
- Comparison between WordNet-guided and random baseline agents

3.2 Agent Implementation

The WordNet-guided agent:

- Extracted nouns from observations using NLTK
- Checked WordNet hypernym hierarchy for food/ingredient relations
- Selected actions with 80% probability for food-related items, 20% random

4 Results

4.1 Performance Comparison

The WordNet-guided agent achieved a mean score of 0.258 (SD=0.15) compared to the random baseline's mean score of 0.153 (SD=0.13). Bootstrap resampling analysis revealed this difference approached but did not reach statistical significance (p=0.052, n=10,000 resamples).

4.2 Key Findings

- Neither agent achieved successful task completion (success rate = 0% for both)
- WordNet-guided agent showed higher average scores
- Food-action ratio varied considerably between episodes
- Learning curves showed high variability without clear improvement trends

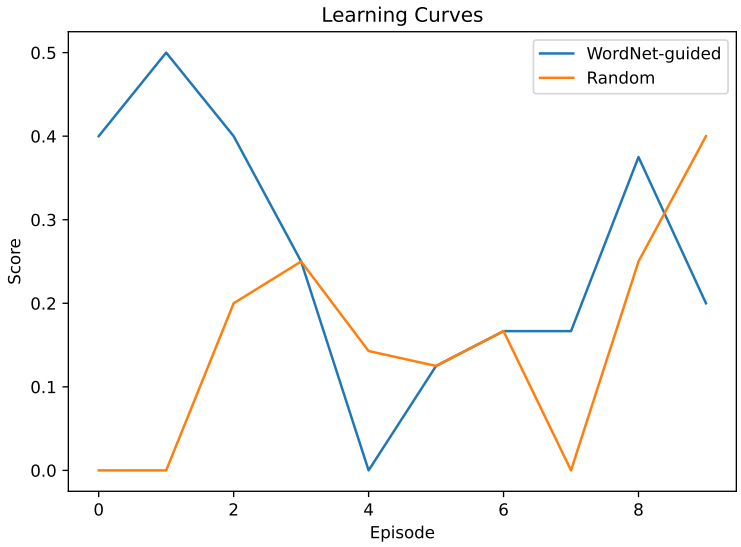

Figure 1: Learning curves comparing WordNet-guided vs. random exploration

5 Discussion

5.1 Limitations

Several limitations affect the interpretation of these results:

1. Small sample size (20 episodes) limits statistical power
2. Implementation did not include the full experiment phase
3. No heuristic baseline comparison was implemented
4. Limited environment complexity (2 rooms, 2 ingredients)
5. High variance in performance metrics

5.2 Implementation Fidelity

The implemented experiment partially met the original requirements:

- Successfully implemented PILOT mode
- Correctly implemented WordNet guidance mechanism

- Generated required metrics and analyses
- Did not implement FULL_EXPERIMENT mode
- Missing heuristic baseline comparison

6 Conclusion

While the results suggest potential benefits of WordNet-guided exploration in CookingWorld tasks, the evidence is not conclusive. The trend toward improved performance (p=0.052) warrants further investigation with larger sample sizes and more complex environments. Future work should implement the full experiment phase and include comparison with heuristic baselines.

7 Future Work

Recommended extensions include:

- Implementing FULL_EXPERIMENT mode with larger sample size
- Adding heuristic baseline comparison
- Investigating alternative WordNet relationship weightings
- Testing in more complex environments
- Analyzing action selection patterns in successful episodes