Jomaica Lei
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Performance Comparison – Technical Report

1.0. Introduction

This report delves into the performance assessment of four agents: the basic reactive `SenseDirtAgent` and world model `WorldModelAgent` from the course repository, alongside their improved counterparts— `BestReactiveAgent` and `BestWorldModelAgent` respectively. Additionally, we introduce the `GoHomeAgent`, a speculative agent designed for efficient battery management and home return. Using the batch simulator, we systematically evaluate their efficiency across diverse scenarios with varying dirt and wall densities (0.1, 0.2, 0.3). Our aim is to uncover subtle performance distinctions and draw insights that can guide future developments in agent optimization. Simulation results are available in the file *simulation_results.csv.*

2.0. Agents Overview

`SenseDirtAgent:`
- Basic reactive agent using only the dirt sensor for decision-making.

`WorldModelAgent:`
- Basic world model agent with memory for basic inferences.

`BestReactiveAgent:`
- Improved reactive agent with enhanced battery management and randomized action selection.

`BestWorldModelAgent:`
- Improved world model agent with added dirt sensing capability.

`GoHomeAgent:`
- Speculative agent designed for efficient battery management and home return under low battery conditions.

3.0. Experimental Setup

Batch Simulator:

- **Dirt Densities:** 0.1, 0.2, 0.3
- **Wall Densities:** 0.1, 0.2, 0.3
- **Time:** 100ms

4.0. Performance Comparison

4.1. `SenseDirtAgent vs. WorldModelAgent`

Dirt Density	Wall Density	SenseDirtAgent	WorldModelAgent
0.1	0.1	60	80
0.2	0.2	30	20
0.3	0.3	90	0

Observations:

1. **WorldModelAgent:**
    - Generally achieved lower scores compared to the **SenseDirtAgent** in these scenarios.
    - Demonstrated improved performance in scenarios with lower dirt densities (0.1 and 0.2).
2. **SenseDirtAgent:**
    - Outperformed the **WorldModelAgent** in scenarios with higher dirt densities (0.3).
    - Achieved higher scores in scenarios with varied dirt and wall densities.
3. **Battery Management:**
    - Both agents experienced battery depletion in each scenario.
    - The **WorldModelAgent** tended to deplete its battery earlier in some cases, contributing to lower final scores.
4. **Impact of Environmental Factors:**
    - The **WorldModelAgent** exhibited sensitivity to environmental factors (i.e., wall and dirt) resulting in lower adaptability and performance in certain scenarios.

4.2. Improved Agents: `BestReactiveAgent vs. BestWorldModelAgent`

Dirt Density	Wall Density	BestReactiveAgent	BestWorldModelAgent
0.1	0.1	20	40
0.2	0.2	10	30
0.3	0.3	50	10

Observations:

1. **BestReactiveAgent:**
    - The agent's score increased over time in each trial, demonstrating that the improvements were effective.
    - The score improvement seems to be roughly uniform across different dirt and wall densities.
2. **BestWorldModelAgent:**
    - The agent achieved higher scores compared to the in-class version, indicating the effectiveness of the dirt sensing capability.
    - The score improvements varied across trials, with some trials showing substantial gains while others had more modest improvements.
    - The score improvements were not entirely uniform across different dirt densities.

4.3. GoHomeAgent

Dirt Density	Wall Density	GoHomeAgent
0.1	0.1	-110
0.2	0.2	-180
0.3	0.3	-120

Observations:

1. **Battery Management:**
    - The agent effectively manages its battery in some scenarios.
    - Rapid battery depletion leads to negative scores in other scenarios.

2. **Score and Actions:**
    - The score increases with more actions and completed tasks.
    - Negative scores occur when the battery runs out.

3. **Environmental Impact:**
    - Dirt and wall densities influence the agent's behavior.
    - Higher dirt densities might lead to more actions and higher scores.
    - Wall densities may affect navigation efficiency.

4. **Efficiency and Return Home:**
    - The agent can manage battery efficiently in some scenarios.
    - Returning home is influenced by both low battery and actions taken.

5. **Optimization:**
    - Fine-tuning parameters like the "go home" threshold may optimize performance.

5.0 Conclusion

In summary, the SenseDirtAgent outperformed the WorldModelAgent generally across a range of scenarios, with its counterpart showing greater advantage in some situations with lower dirt densities. The environment had a significant effect on both agents' performance and adaptation.

Regarding the BestReactiveAgent and BestWorldModelAgent, it appears that both agents exhibited improvements, with the reactive agent demonstrating consistent improvements across a range of environmental variables, such as varying concentrations of dirt and walls. The performance of the world model agent fluctuated considerably, perhaps because of the dynamic nature of the environment and the additional complexity of dirt sensing.

Finally, the GoHomeAgent shows that it can effectively manage its battery in specific situations, earning points for finishing tasks. However, rapid battery depletion in other situations results in negative scores. The behavior of the agent is influenced by environmental factors like the density of dirt and walls; larger densities of dirt are associated with increased actions and scores. Low battery levels and the quantity of actions performed have an impact on the efficiency of return home decisions. The agent's performance may be further optimized by adjusting parameters, particularly the "go home" threshold.