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Agents

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Abstract

This report explores the performance of different types of agents in varying environments using implementations from the Aimacode repository. Initially, the hypothesis suggests that simple reflex agents excel in predetermined environments, while incorporating a randomized function may enhance performance in unknown environments. Furthermore, it posits that reflex agents with state outperform simple reflex agents by considering past states. The report outlines experiments conducted to test these hypotheses, including the design of performance-measuring environment simulators and comparative analyses of different agent types. Results indicate that reflex agents with state consistently outperform randomized reflex agents in environments with unknown variables. The findings support the hypothesis and underscore the importance of adaptive decision-making processes in artificial intelligence agents. Overall, this study demonstrates the utility of repositories like Aimacode in facilitating research and experimentation in artificial intelligence.

A repository is a type of centrally located storage where people can store all their project's files and resources [1]. Public repositories are accessible to everyone on the internet and often solve common problems. Aimacode is a very useful public repository for artificial intelligence students, since it has multiple implementations of algorithms and problems from Russel And Norvig's "Artificial Intelligence – A Modern Approach" textbook [2]. With this assignment we will use some of the predefined algorithms and objects in the Aimacode repository to solve two problems from the "Artificial Intelligence – A Modern Approach" textbook by implementing performance-measuring environment simulators, designing a simple reflex agent with a randomized agent function, and designing a reflex agent with state [3]. The current hypothesis suggests that simple reflex agents perform better in environments where all details are predetermined. Additionally, the hypothesis proposes that incorporating a randomized agent function can enhance the performance of a simple reflex agent when the environment's geography is unknown. However, this inclusion may lead to inconsistencies in optimal decision-making when the environment's geography is known. Furthermore, the hypothesis posits that reflex agents with state can outperform simple reflex agents by considering past states, thus enabling more informed decision-making processes.

The first part of the assignment involved implementing a performance-measuring environment simulator for a vacuum-cleaner world with two rooms. This is an exercise from the class's textbook; however, the Aimacode repository already has agent implementations for a vacuum-cleaner world with two rooms. The only thing missing would be the performance measuring environment simulator. For this, we used an already integrated performance variable in the agent object that calculates a performance score by adding 10 for each dirty room cleaned and removing 1 each time the agent moved. An example of the performance score output can be seen in Figure 1.

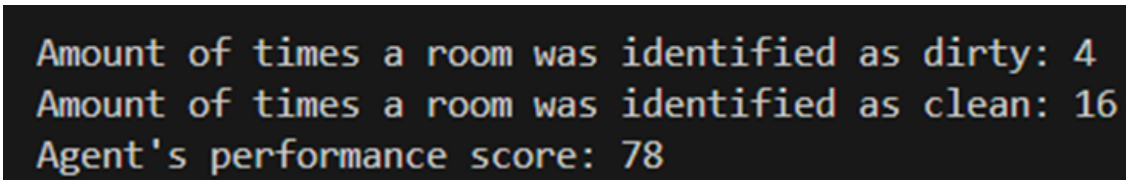


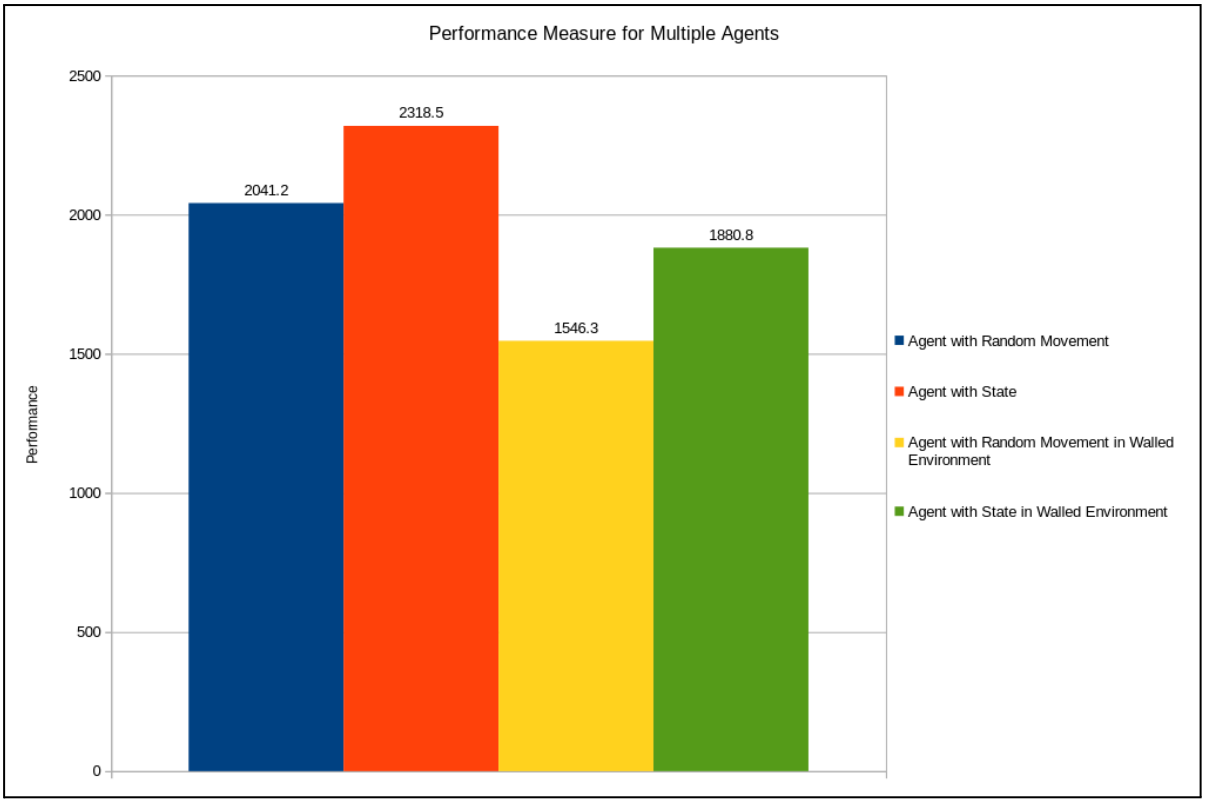
Figure 1: Output example of the performance-measuring environment simulator

In this example, the agent performed 10 actions, and its performance score was 78. Moreover, a counter was introduced to keep track of the number of rooms perceived as clean, alongside a separate counter for rooms perceived as dirty. These counters are then printed and can be seen in Figure 1 as 4 and 16 for the dirty and clean counters respectively.

The second part of the assignment considers a modified version of the vacuum environment where its geography and the initial dirt configuration are unknown. For this type of environment a simple reflex agent is not perfectly rational, because this

type of agent relies on current perceptions of the environment to make decisions, and without knowledge of the entire environment, it may not always choose the most optimal action. However if a simple reflex agent were to have a randomized agent function, it can potentially outperform a deterministic simple reflex agent. By introducing randomness, the agent might explore different actions and adapt better to unknown environments. Nevertheless, the performance improvement depends on the specific characteristics of the environment and the randomization strategy. With this in mind, it is possible to design an environment where a randomized agent performs poorly. For instance, if the environment has a clear and optimal path to follow, introducing randomness may lead the agent to deviate from the optimal route more frequently. In scenarios where a deterministic approach is advantageous, the randomized agent could perform sub-optimally. Additionally in environments with random obstacles, a randomized agent can easily get stuck and not make any progress leading to suboptimal performance as well. An alternative to both of these approaches would be a reflex agent with a state. This type of agent can potentially outperform a simple reflex agent, especially in environments where knowledge of the current state provides valuable information about the optimal action. The agent can maintain an internal state representation and make decisions based on both the current perception and its internal state.

To verify our assumption 4 tests were performed, one for a simple reflex agent with a random component, one for a simple reflex agent with state, one for a simple reflex agent in an environment with obstacles (called walls), and finally a simple reflex agent with state in an environment with walls. The performance measure for these tests gave the agent 100 points for each room cleaned and subtracted 1 point for each move. The Values shown in Graph 1 are the averages of 10 runs.



Graph 1: Comparison of the performance of multiple agents

After designing a 10 by 10 environment with random dirty locations and no obstacles, the reflex agent with state performed better with an average performance score of 2318.5, while the random reflex agent had a slightly lower performance score average of 2041.2. This outcome highlights the effectiveness of incorporating state information for more informed decision-making in environments. Subsequently, a 10 by 10 environment where 20% of the locations are randomly generated as walls was designed. In this new environment with random walls, both agents had a significant drop in performance compared to the previous environment. However, the reflex agent with state still had a higher performance score average of 1880.8, outperforming the random reflex agent's average performance score of 1546.3. The disparities in result emphasize the importance of adaptability and strategic decision-making, where the reflex agent with state showcased a better navigation in the presence of obstacles.

In conclusion, repositories are an incredibly useful tool used by developers to share and utilize already implemented code. Aimacode is a great example of a useful repository since it provides multiple implementations of problems listed in artificial intelligence textbooks. This repository has a base code for environments and reflex agents which were used across this assignment for additional implementations such as random reflex agents and reflex agents with states. With the results obtained during the assignment, we can compare and see if our initial hypothesis was correct. The initial hypothesis states 3 things. First it states that simple reflex agents have higher performances when used in environments with predetermined details, secondly that incorporating a

randomized function in the agent can enhance a simple reflex agent's performance when the environment's geography is unknown, and finally that having a randomized function in a simple reflex agent gets out performed by having the reflex agent consider past states to make more informed decisions. After analyzing the results, it can be inferred that the hypothesis is overall correct, because simple reflex agents struggle in randomized environments, adding the randomized function to the simple reflex agent allowed it to have a decent performance when the environment is not known by the agent, and finally the performance score of the reflex agent with state was overall higher than the performance score of the reflex agent with a randomized function.

References:

[1] V. Gupta, “What is a repository?,” *Built In*, Feb. 07, 2023. https://builtin.com/software-engineering-perspectives/repository

[2] “aimacode,” *GitHub*. https://github.com/aimacode

[3] S. Russell and P. Norvig, *Artificial Intelligence: A Modern Approach*, 3rd ed. Upper Saddle River, NJ, USA: Prentice Hall, 2010.

Task Distribution:

- Ramon J Rosario Recci - Collaborated on the analysis, interpretation of results, collaborated writing the assignment's formal report.
- DAVID A CASTILLO-MARTINEZ - Implemented Python code for the agents and environments using its functions, and collaborated on writing the assignment's formal report.
- CHRISTIAN J PEREZ-ESCOBALES - Collaborated on the code, analysis, interpretation, created the presentation, and edited the video presentation.