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CS 4300 - 001

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Assignment A5: Monte Carlo Probabilistic Agent

1. INTRODUCTION: RAJUL

Monte Carlo methods (or Monte Carlo experiments) are a broad class of computational algorithms that rely on repeated random sampling to obtain numerical results. Their essential idea is using randomness to solve problems that might be deterministic in principle. This is what was used for this experiment.

The goal was to create an Agent in the Wumpus World that relied on the probability of safety in the spaces around it. This report will study the performance statistics of an agent using Monte Carlo methods to solve for likelihoods of pits and a Wumpus in the Wumpus world. This agent is expected to be smarter than the Hybrid Agent that used a combination of Resolution Theorem Proving and A star. In addition, this agent will also attempt to shoot the Wumpus. Some of the questions that need to be answered are:

1. What is the mean score, variance, confidence interval, number of successes, and number of failures for 50 given boards?
2. What impact does MC have on the score?

2. METHOD: CONAN

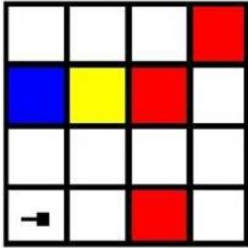
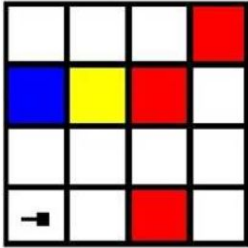
First, there is an CS4300_WP_estimates method that takes in the agent's knowledge of breezes and stench and applies Monte Carlo methods to generate probabilities. This means it

randomly generates boards and checks if they are in accordance with the breeze and stench information the agent knows. If it does find a board that satisfies that, it adds it to the probability count. It then uses this to calculate the probability of a pit or Wumpus on every cell of the board.

This essentially helps the agent traverse the world and also attempt to kill a Wumpus before taking a risk. The agent usually sticks to safe spots while travelling, but when it decides to take a risk to an unknown frontier, it looks at the probability of the frontier cells and decides to pick the one with the least probability of having a pit and Wumpus. It also uses these probabilities to shoot at a cell with the highest chance of a Wumpus.

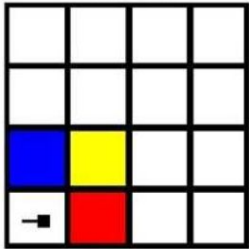
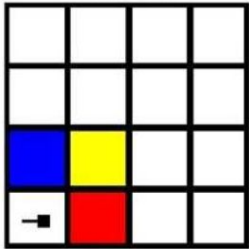
3. VERIFICATION OF PROGRAM: RAJUL

One way to verify our program is to check it against previously known boards. In this case, we use the boards from the previous assignment and compare the Hybrid Agent.

Agent	Hybrid Agent	Probabilistic Agent
Trace	0, 3, 1, 3, 3, 1, 3, 1, 3, 1, 1, 4, 3, 3, 1, 1, 2, 1, 6	0, 3, 1, 3, 3, 1, 3, 1, 3, 1, 1, 4, 3, 3, 1, 1, 2, 1, 6
Score	982	982
Board	<p style="text-align: center;">Board 2</p> 	<p style="text-align: center;">Board 2</p> 

Here we see that the Probabilistic Agent on the right traverses the board in the exactly the same way as the previous agent we built. This shows that the agent performs at least as well as the hybrid agent (not looking at time) and successfully solves the board.

Moving on to a more complex case that was previously failed by the Hybrid agent, we look at two different possibilities for the probabilistic agent. Since it is trapped, it has an almost 50/50 chance to shoot and kill the wumpus. These are the two cases below:

Agent	Probabilistic Agent Dies	Probabilistic Agent Shoots
Trace	0, 5, 3, 1	3,5,1,1,1,2,1,2,1,1,4,2,1,3,1,6
Score	-1052	935
Board	<p style="text-align: center;">Board 5</p> 	<p style="text-align: center;">Board 5</p> 

It is important to first state that the agent above, tries to kill the wumpus before it takes a risk of any sort. Here, for the death case, the wumpus takes a shot at the wrong spot as the probability from MC was higher at the (2,1). As for the other case, the agent decides to shoot at the correct position and kills the Wumpus. The agent is then free to traverse the board and retrieve the gold, which is the desired result.

4. DATA AND ANALYSIS: CONAN

The data presented below was collected for various number of samples to the estimates method that uses Monte Carlo. 5 trials were run for the same set of 50 boards.

	Mean Score	Number Successes	Number Failures
No MC	-513.752	61	189
10 Samples	30.404	130	120
15 Samples	251.072	158	92
20 Samples	364.56	173	77

Table 1. Table for Results Reporting

We can see that the Mean Score of each run increases when sample size increases. The same can be said for number of successes, which causes number of failures to decrease.

	Mean Score	Variance	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
No MC	-513.752	7.3297e+05	-619.8798	-407.6242
10 Samples	30.404	9.7953e+05	-92.2818	153.0898
15 Samples	251.072	9.0850e+05	132.9181	369.2259
20 Samples	364.56	8.2023e+05	252.2924	476.8276

Table 2. Table for Statistical Calculations

It is seen above, that the case with MC has a relation related to the number of samples. The confidence intervals also deviate from the negatives since negative scores are less prevalent with more successes.

5. INTERPRETATION: RAJUL

From the above data, we see that the mean score for each case increases with the increase in number of samples. This creates a direct correlation of the number of samples to optimal performance on the boards. The case with no Monte Carlo used, failed the most with the worst mean score whereas the case with 20 samples (the most), has the least number of fails. With samples, the variance is seen to be decreasing due to increase in accuracy of the Monte Carlo method. The one case with No MC fails for a large number of trials consistently, so its variance is smaller.

It is clear from the above data that Monte Carlo clearly helps the performance of the agent, which is the same as seeing the relation with Number of Successes.

6. CRITIQUE: CONAN

Although this experiment was much more efficient than the Hybrid Agent tested earlier, it still had its inconsistencies. This is due to the random sampling that MC heavily relies on. It does improve a lot of cases, but the agent still relies on chance which makes it inefficient on some cases.

In addition, it will also help to get information on more Sample varieties to study the relation of variance with the number of samples.

Furthermore, One way to combat this was to increase the number of sample spaces to a much greater number. Although it would take very long to gather data, it could be more accurate than the data obtained with less samples. Again, there will still be a part of the agent that relies on chance, but it will be less so.

7. LOG: RAJUL & CONAN

Rajul: I spent 10.5 hours on the agent and 6 hours on the Lab Report.

Conan: I spent 8 hours on the agent and 6 hours on the Lab Report.