Lab Report A5
CS4300
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1. Introduction

For this lab we will study the performance statistics of an agent using Monte Carlo methods to solve for likelihoods of pits and Wumpus in the Wumpus world. Through the creation of an agent which uses rules to search for the gold while using the Monte Carlo method to estimate the likelihood in unexplored cells and then to prioritize them based on their likely safety. We will then run our agent against a given set of 50 boards, while using different sample sizes of Monte Carlo, and calculate the mean, variance, confidence interval, and the number of successes vs. failures. We will answer the following question:

Does increasing the number of Monte Carlo samples lead to a higher success rate?

2. Method

We created an agent which instead of using an RTP to figure out where to go, it uses Monte Carlo probabilities to determine what the safest path is. While exploring we use the heuristics to build a knowledge about stenches and breezes. In each cell we explore, including the first cell you spawn in, we check the heuristics. If there's a glitter we immediately plan to pick up the gold and then head back to the start and climb out. If there's no stench or breeze we know that our neighboring cells are safe and add them to a list of safe places we can visit, otherwise they are added to our frontier. We then use Monte Carlo (CS4300_WP_estimates) to determine the probabilities of pits and wumpuses based on the heuristic knowledge of breezes and stenches we have gathered so far. After this we calculate a plan, first trying to go to a safe place we haven't visited yet else if there are no safe places left and we have an idea of where the wumpus is we try and shoot the wumpus in the most likely cell it is in otherwise we go to the cell who has the least likely chance of having a pit. We continue to explore like this until we have either found the gold and escaped or died.

3. Verification of Program

$$\text{Board} = \begin{bmatrix} 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 1 & 0 & 0 & 3 \\ 0 & 2 & 1 & 0 \end{bmatrix} \quad \text{Expected pits} = \begin{bmatrix} .2 & .2 & .2 & .2 \\ .2 & .2 & .2 & .2 \\ 0.5 & .2 & .2 & .2 \\ 0 & 0.5 & .2 & .2 \end{bmatrix}$$

$$\text{WP\_Estimates 20 trials} = \begin{bmatrix} .1 & .2 & .15 & .3 \\ .2 & .1 & .1 & .15 \\ .45 & .05 & .25 & .25 \\ 0 & .55 & .25 & .05 \end{bmatrix}$$

Based on the returned pit probabilities our agent would turn left, go forward, and die.

4. Data and Analysis

	Mean Score	Successes	Failures	Variance	CI
No MC	26.72	26	24	1.0098e+06	[-207.05, 260.49]
10 MC	442.34	34	16	5.1441e+05	[275.49, 609.19]
15 MC	504.848	39	11	4.4954e+05	[318.87, 660.83]
20 MC	482.676	37	13	4.7538e+05	[322.28, 643.07]

Table 1: Means, Successes, Confidence Intervals, and variances for different MC sample sizes

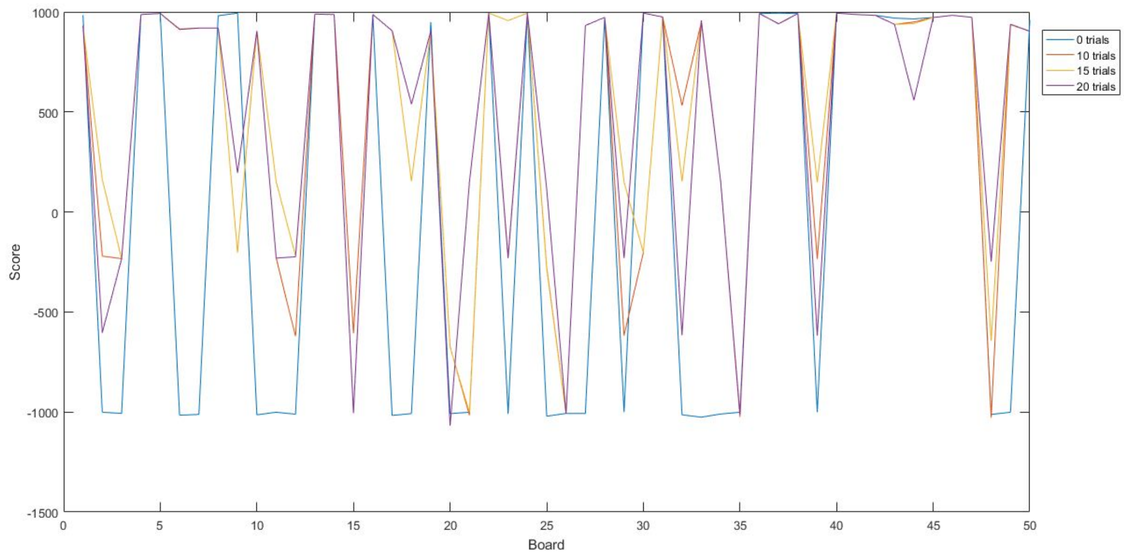

Figure 1: Scores of each MC sample size by board

5. Interpretation

We can begin by examining the table in the previous section. We can see that no MC yielded the worst success rate and score. This intuitively makes sense as having no knowledge to base our actions off of, there is a very slim chance of randomly guessing all of the right moves to get the gold without dying. One would expect that as more samples are added there would be a greater chance that the predictions generated were close to their real values, which can see seen in Table 1. With the variation of the number of samples that we generate being so close to one another, there is an argument to be made in terms of the values seen in the above table, however with some of the boards forcing the agent to make a guess when no safe places are available to travel to, it makes sense that the values seen when MC is used are close to one another with it being random as to whether or not the agent will make a safe move or not. As more samples are added, there is a greater chance of the values being the exact values, thus leading to a greater chance of survival.

The graph shows how each different sample number behaved when dealing with each individual board. Here we can see the consistency for each sample size, with similar results as seen in the table.

6. Critique

Through the course of this last week we have learned more about random sampling and Monte Carlo estimates and their application in both AI and other types of problems. For example Monte Carlo can be used to help our agent navigate the Wumpus World or to estimate the area of a circle. It is also very interesting in comparing Monte Carlo to RTP. In our case there were instances where trying to create a random world which fits our knowledge is difficult, especially as our knowledge of the world grows but through discussion with Professor Henderson we found several optimizations which could help minimize these problems. Such as only randomizing the areas of the world we don't know. I'm sure there are many more ways in which this could be optimized to push it even further past RTP.

7. Log

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Coding Portion (Worked together): 10
Report (Derek): 2
Report (Matt): 2