Assignment 2 – CS4300

A\* Search in a Wumpus World

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# Introduction

To further continue to explore the Wumpus World we measured the complexities of variations on an A\* search. Option 1, we insert new states before states rated to be equal or greater. Option 2, we insert after states rated equal or lesser. A Manhattan distance heuristic to measure the distance between any given state and the goal state to rank different states against each other. We ran 2000 randomly generated boards, each with a 20% change of having an empty cell be a pit, to answer the following questions

* What is the is mean number of search nodes produced by A\* for options 1 and 2?
* Is option 1 10% better than option 2?

# Method

Description of algorithms  
Specific features of method, parameters in play, what data sets are used

Are the new children nodes added to the tree immediately when a node is expanded from the frontier?  
When is a node checked if it is a solution?  
Produce results even with no solution to goal (include stats of search trees that fail)  
Other issues you deem important to understand the data

The method used here is simply to generate a large number of samples and compute the mean, variance and confidence of the result. An alternative would be to run a large number of trials where each trial would get a fixed number of samples from rand, and then compute the mean and variance of each trial, and then compute the mean and variance over all those trials. This latter approach was not implemented.

# Verification of Program

To test out that program works we will be comparing our results to hand calculations of the following boards

|  |  |  |  |
| --- | --- | --- | --- |
|  |  |  |  |
|  |  |  |  |
| W |  |  |  |
| gold | pit |  |  |

|  |  |  |  |
| --- | --- | --- | --- |
|  |  |  |  |
|  |  |  |  |
| w | pit | pit |  |
|  |  |  | gold |

|  |  |  |  |
| --- | --- | --- | --- |
|  |  |  | gold |
|  |  |  |  |
| pit |  |  |  |
|  | w |  |  |

2

3

1

1

left

right

2

1 node

right

4 nodes

3

forward

forward

left

right

left

right

right

right

forward

10 nodes

Results from Matlab

* Board 1 –
* Board 2 –
* Board 3 –

Minimum tree size: 1 node – if the gold is in the player spawn position.

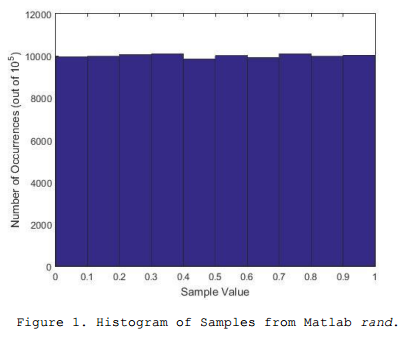
The maximum tree size: 14 cells (no pits, 1 gold cell, and 1 wumpus cell)

# Data and Analysis

Description of data and how it is used/organized for training and testing  
Results from experiments (graphs, tables, means, variance, confidence intervals)  
Describe relationships found or qualitative description of results  
Discuss implications of statistical results

Give 4x4 tables with the number of nodes in the search tree for each of these options when the gold is at (x.y)  
Plot actual size of individual trial results and a histogram

Figure 1 shows the data collected from Matlab rand.



# Interpretation

ANSWER QUESTIONS

Answer questions posed in into, use analysis to support conclusions  
Discuss future work and extensions

The results produced by rand are very close to the theoretical values of the mean and variance and the confidence interval at the 95% level is very short. Thus, the mean and variance results are close enough to the theoretical values to be acceptable in most applications.

# Critique

Demonstrate concepts understood, generate result of experiment with respect to raised questions and context  
Specific issues with technique (parameters, constraints)  
Problems and improvements

A better way to set up this experiment would be to pose a (null) hypothesis and then apply standard statistical methods to reject the hypothesis (or not). In addition, the number of samples could be varied from a small number to some very large number to examine the change in mean and variance as a function of number of samples; in theory, due to the Law of Large Numbers, this could show convergence properties.

# Log

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Kyle Heaton

* 57 min – Reviewing assignment, fleshing out requirements, outlining report
* 98 min – Writing helper functions and writing report

# Appendix

MATLAB Code Files with Brief description:

* + CS4300\_A2\_20percent\_Pit\_Board.m – Helper function to generate Wumpus World boards. The gold and wumpus are placed randomly, then every empty cell has a 20% change of having a pit.
  + CS4300\_ A2\_Calculate\_Tree\_Size.m – Helper function to determine the size of the tree for tree node statistics
  + CS4300\_ A2\_Expanded\_States.m – Helper function to generate all of the possible reachable states from a state that has been passed in
  + CS4300\_ A2\_Manhattan\_Distance.m – Helper function to calculate the Manhattan distance for a state from the starting point
  + CS4300\_ A2\_Wumpus\_A\_star1.m – An A\* search algorithm to search a given wumpus board for a path to the gold