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CS 4300 - 001

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Assignment A4b: Hybrid Wumpus Agent

1. INTRODUCTION: CONAN

A Hybrid Wumpus Agent is a Wumpus World artificial intelligence that utilizes Resolution Theorem Proving (RTP). It does this by updating the RTP's knowledge base (KB) with new information every turn and builds a plan for the steps it needs to take to reach a goal. However, it also makes use of the A* search algorithm to generate a quick path to a specific known location. That's how the agent is a hybrid between two different algorithms, which makes it a much more robust artificial intelligence. RTP is specifically used for determining which spaces are safe in the Wumpus World and which spaces haven't been visited yet.

The questions we seek to answer with the Hybrid Wumpus Agent are:

1. How does the agent's knowledge of the world evolve with each time step?
2. What are the actions and score for the Hybrid Wumpus Agent on 3 given boards?
3. What are the advantages and disadvantages of using a propositional logic approach with a Wumpus Agent?

2. METHOD: RAJUL

By using RTP and A*, the Hybrid Wumpus Agent constructs a plan in order of decreasing priority. The first priority for the agent is to check if there is glitter. Since glitter only appears when the agent is on a space with gold, it has reached its goal. The agent will then grab

it, follow a route back to the entrance, and climb out. If there is no glitter and no previous plan to execute, the agent will then use A* to search for a safe route to an unvisited safe location.

However, if there is no glitter or any safe spaces, the agent will look for any locations that are not provably unsafe. A not provably unsafe location is one where it can't be proven whether there is a wumpus or pit on it, so it's taking a risk to move there. Otherwise, if none of those choices are possible, the agent plans a route back to the entrance and climbs out.

To utilize both RTP and A*, the agent takes in a percept of whether the space it's on contains a stench, breeze, or glitter. The agent then converts these percepts into sentences that can be used in the KB for RTP with a function called CS4300_make_percept_sentence. The agent then updates the KB with a function called CS4300_tell, which adds the sentences to KB only if they don't already exist in there. Afterwards, to compute whether a space is safe or unsafe, the agent uses a function called CS4300_ask to see whether a certain theorem can be proved with the given KB. Finally, the agent routes a path to the space it wants to move to with A* using a function called CS4300_plan_route.

3. VERIFICATION OF PROGRAM: CONAN

Below, we see board 1 and the trace for the board according to our program in the Table 1. If we simply look at the board, we see that a correct solution would be to turn left and collect the goal. This is exactly what the code does. Through the table below, it is observed that the agent would determine positions (2,1) and (1,2) as safe. It arbitrarily picks one of the two (in our case (1,2)). Here it sees the glitter and initiates the grab and run. This causes the wumpus to grab the gold (action = 4) ,return to (1,1) and climb out (action = 6)

Table 1: Agent Trace for Board 1			
x	y	dir	action
1	1	0	0
1	1	1	3
1	2	1	1
1	2	1	4
1	2	2	3
1	2	3	3
1	1	3	1
1	1	3	6

Board 1

Here, the Hybrid Wumpus Agent trace is the exact same as when we solve it by hand.

This is a simple case but verifies the sanctity of the KB and the AI algorithm.

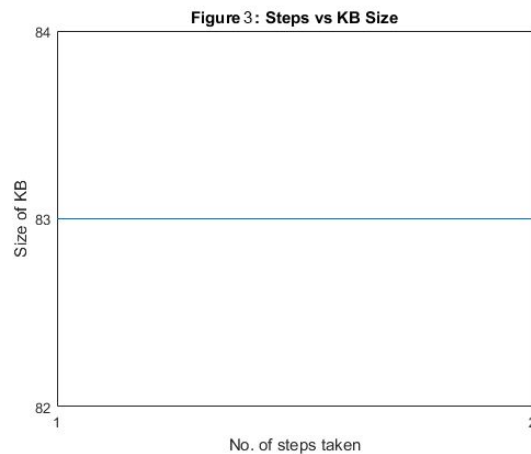
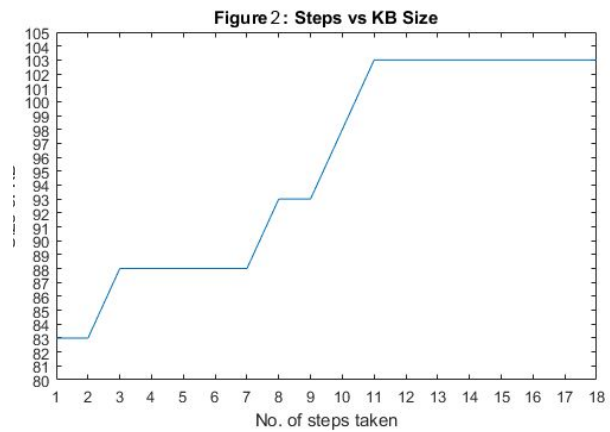
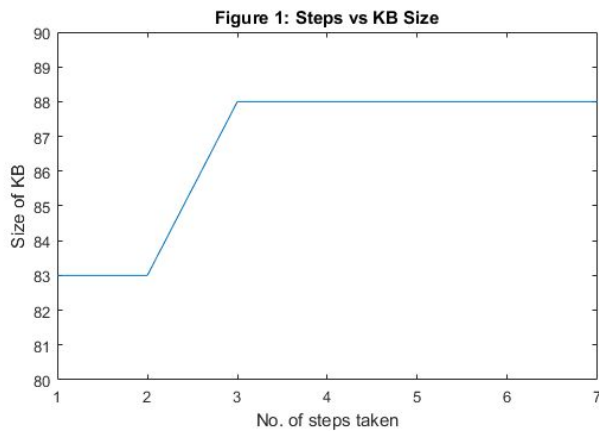
4. DATA AND ANALYSIS: RAJUL

Table 2: Hybrid Wumpus Agent's Action and Score for each Given Board			
Data	1st Board	2nd Board	3rd Board
Action:	0, 3, 1, 4, 3, 3, 1, 6	0, 3, 1, 3, 3, 1, 3, 1, 3, 1, 1, 4, 3, 3, 1, 1, 2, 1, 6	0, 3, 1
Score:	993	982	-1002
Board:	<p>Board 1</p>	<p>Board 2</p>	<p>Board 5</p>

In Table 2, we see the Actions taken and Score of the Hybrid Wumpus Agent for each of the given boards. Take notice of how many more actions need to be taken for the 2nd board due

to it utilizing RTP for determining the safe space (2,2) in the beginning. The first board's action sequence is minimal due to it luckily choosing the correct space on the first arbitrary choice.

Lastly, it is seen with the 3rd Board that the Hybrid Wumpus Agent dies due to it being impossible to reach the gold. The score also reflects that where the agent simply turns and runs into the Wumpus.



Above, we see three graphs representing the growth of the knowledge base with the number of steps taken for every board. Figure 1 above is the graph for board 1. We see that the

knowledge base increases with the number of steps. Similarly, we see this trend with Figure 2 for board 2 and figure 3 for board 3.

5. INTERPRETATION: CONAN

In the graphs in the previous section, we see that the KB always grows as the agent moves in the world. This is as expected. We do also notice that these KB stop growing sometimes towards the end, and in case of Board 3, did not grow at all. This is due to a few reasons. Mainly, it is because the agent remains in a similar area of the board for all three boards so once it gains knowledge for that area, it never adds new data. Also, as for board 3 and end of the graphs for board 1 and board 2, this is the period where the agent collects the gold and makes it way back to (1,1). It travels only on familiar territory at this time and hence, not collecting any new data for KB.

With the Action and Score for each board, it seems the values are highly dependent on the board layout itself. It's also noted that for the first board, our Hybrid Wumpus Agent takes a slightly less amount of actions to reach the gold because it chooses to go to (1,2) rather than (2,1) initially.

The advantage of using a propositional logic approach to the Wumpus Agent is that it makes much more intelligent and informed decisions with every step it takes with RTP. This makes it much more likely that it will survive a given board layout. However, the disadvantage to this is that it is very slow. To solve the 2nd Board, the Hybrid Wumpus Agent takes about 2 minutes to run.

6. CRITIQUE: RAJUL

With each time step, the CS4300_ask function becomes more expensive due to having more and more symbols to work with. A fix that can be made would be caching the results of previous calculations to build on them rather than recalculating them.

There are also other possibilities for improvement where lots of places in the code are very inefficient. The RTP code is very slow with some n^3 functionality. As for the agent, it currently picks an arbitrary position from a list of possible destinations. It could be more beneficial to travel to the shortest possible destination location.

7. LOG: RAJUL & CONAN

Rajul: I spent 9 hours on Part A4b and 4 hours on the Lab Report.

Conan: I spent 7 hours on Part A4b and 6 hours on the Lab Report.