Project 1 Report

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Structure of the approach

Variant 1: A*
For variant 1, the only world without a monster, we imagine that any approach we choose to do would work. A* simply creates a path from the character to the exit. With no external factors to consider, this algorithm should work 100 percent of the time.

Variant 2: A* and Expectimax
Since the monster is moving randomly and not in an optimal way where it's searching for the character, the best approach to this would be a probabilistic approach which is why we chose Expectimax. The chance node here was used on the possible moves that the monster can do.

Variant 3-5: A* and Minimax
In these variants we are exposed to more logical monsters, namely the self-preserving monster and the aggressive monster. As such, we need to put more thought into what the best move for the monsters would be. Minimax considers both the character and the monster's best move.

We did however consider that minimax should not be used for all cases:
- When the character was not close to monsters
- When the character was close to the exit
- When the character had a clear path to the exit, by getting behind the monster
  - If and only if the astar path length of the character was less than that of the monster, we would always make it to the goal, before the monster makes it to us.

In those cases we used A* or forced the best action to be the exit for each case respectively. This could have been used with expectimax for optimization, however it was not considered at the time.

Interesting tidbits

Individual sections for each interesting bit of your approach

Expectimax:

- getLegalActions() - this helper function list the possible moves that the character/monster can do. This is determined by the walls and the bounds. In the character case, this is also determined by whether there's a monster nearby.
- The utility value in this algorithm was determined by the score and the A* distance from the character to the exit. In cases that the character is killed or the character reaches the exit, the utility value is decremented and incremented more accordingly. Another approach for the utility that ultimately failed was using the euclidean distance between the character and the exit. Without consideration for the path created by A*, the character would be stuck in a corner of the map.
- A flat depth of 2 was used for this algorithm with variant 2. A depth of 3 was used originally and that worked but it was too slow so we opted for 2 which still have a perfect success rate.
- The terminal state is set to be whenever the character is killed, when it reached the exit, or when the flat depth is reached.
- The probability for each action was simply 1/(total number of possible moves)

Minimax

- Reward - this provides the utility for each state -- where the score is impacted by the length of the A* path and the distance between the character and the monster. Instead of adding the distance directly, we mapped the distance with some fixed value instead.
- Minimax terminal states -- Since we are using minimax just as a means to avoid the monster, as part of the terminal states (exiting or dying from the monster) we made sure it stops after some number of iterations. The main difference between the terminal states of the expectimax and the minimax-A* algorithm is the values assigned.

Experimental Evaluation

How many times does your character survive in each situation?

Variant 1: 100%, there's no monster so as long as A* works the character survives.

For the remaining variants, we ran the game with 20 different seeds. As such:

Variant 2: 100% survival with expectimax. Was able to lower the depth searched to 2 from 3 to speed up performances.

Variant 3: 90% survival with expectimax. The monster catches the character from time to time but expectimax still performed pretty well. 100% survival with minimax

Variant 4: 40% survival with expectimax.

Variant 5: 50% survival with expectimax. In this variation, we had a stupid monster and an aggressive monster. Without any issues, the character would be able to pass the stupid monster. Like in variant 4 using expectimax, all deaths with this variation was due to the aggressive monster.