CSC384: Introduction to AI

Assignment 2: Multi-agent Pacman

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Question 2: Minimax (2 points)

Note that Pacman will have suicidal tendencies when playing in situations where death is imminent.
Why do you think this is the case? Briefly explain in one or two sentences. (2 points total)

Since we have a depth limit, we can't evaluate all possible moves, so minimax chooses the best action available, limited to the search depth. Hence, when death is imminent, minimax still needs to pick an action (move), and it might be better to be suicidal rather than prolong life for a limited length of time, and then die, because the latter case leads to a more negative score.

Question 3: Alpha Beta Pruning (4 points)

You should notice a speed-up compared to your MinimaxAgent. Consider a game tree constructed for our Pacman game, where *b* is the branching factor and where depth is greater than *d*. Say a minimax agent (without alpha-beta pruning) has time to explore all game states up to and including those at level *d*. At level *d*, this agent will return estimated minimax values from the evaluation function.

a) In the best case scenario, to what depth would alpha-beta be able to search in the same amount of time? (1 point total)

   Since alpha-beta search is just minimax, but with pruning, we know from class that in the best-case, alpha-beta search is in $O(b^{m/2})$. Therefore, in the best-case, alpha-beta search with pruning should be able to reach a depth of 2*d* in the same amount of time as minimax reaches a depth of *d*.

b) In the worst case scenario, to what depth would alpha-beta be able to search in the same amount of time? How might this compare with the minimax agent without alpha-beta pruning? (2 points total)

   In the worst-case, there would be no pruning, so alpha-beta would be able to search to the same depth as minimax. Alpha-beta search without pruning is exactly minimax (more or less!).

True or False: Consider a game tree where the root node is a max agent, and we perform a minimax search to terminals. Applying alpha-beta pruning to the same game tree may alter the minimax value of the root node. (1 point total)

False

Question 4: Expectimax (6 points)

Consider a game tree where the root node is a max node, and the minimax value of the tree is v_M . Consider a similar tree where the root node is a max node, but each min node is replaced with a chance node, where the expectimax value of the game tree is v_E . For each of the following, decide whether the statement is **True or False** and briefly explain in one or two sentences your answer.

a) **True or False:** v_M is always less than or equal to v_E . Explain your answer. (2 points)

   This is True.
   MIN will always pick the minimum value among its choices. eg) given (1, 2, 3) pick 1.
   On the other hand, replacing MIN, the chance node will be (1 + 2 + 3) / 3 = 2 in the case above.
   For every MIN node, the chance node will have a more optimistic value.
   Hence, every time a MAX node gets to choose, it's choices are all of greater value than when MIN got to choose.
   Therefore, v_M is always **less than or equal** to v_E

b) **True or False:** If we apply the optimal minimax policy to the game tree with chance nodes, we are guaranteed to result in a payoff of at least v_M . Explain your answer. (2 points)

   This is True.
   The reasoning is the same for part (a). Basically, every chance node will be more optimistic than its counterpart MIN node, so at the very least, we could still end up with v_M , but we could end up with a greater value of the game tree.

c) **True or False:** If we apply the optimal minimax policy to the game tree with chance nodes, we are guaranteed a payoff of at least v_E . Explain your answer. (2 points)

   True
   Assume that we apply the optimal minimax policy to the game tree with chance nodes.
   Let v_X be the value of this game tree.
   By the definition of v_E and by our assumptions from the answers above, we have $v_X = v_E \geq v_M$.

   Since we have $v_X = v_E$ then it is true that we are guaranteed a payoff of at least v_E (unless I am misinterpreting the question, or maybe this is a trick question?)