CSC384 A2 Written Answers
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1. 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)
Because if Pacman is about to die, then it would be better to die earlier rather than later score-wise.

2. 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)
   $O(b^{2d})$ (twice as deep).

   (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)
   $O(b^d)$ if no pruning occurs, which is the same as normal minimax.

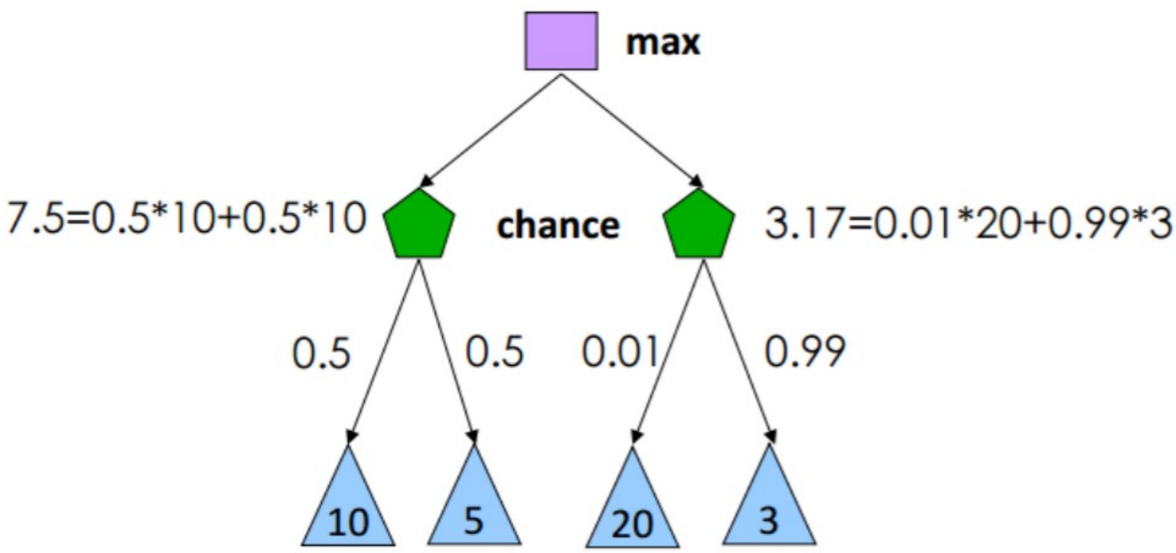
3. **True or False**: Consider a game tree where the root node is a max agent, and we perform a minimax search to terminals. Applying alpha-beta pruning to the same game tree may alter the minimax value of the root node. (1 point total)
False, alpha-beta pruning will always give the minimax value for the root node as minimax would, however, if there are multiple optimal paths, we may get a different path with alpha-beta pruning.

4. 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)
   True, if we translate the minimax min node values into chance nodes, it would just have a probability of 1 for choosing the min child, with every other child being chosen with a probability of 0. Meanwhile a real chance node should never have probabilities of 0 or 1 (otherwise there is no chance involved), but even if it did, mathematically $v_M \leq v_E$

   (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)
   False, consider the expectimax tree on the following page with probabilities on the right child flipped, so the new expected value is $19.83 = 0.99 \times 20 + 0.01 \times 3$. The v_M value would be 5 (left child) in this tree, but minimax would choose the right child since the expected value of the right child is higher. But we could get unlucky and get a value of 3 from the right child instead of 20.

   (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 vE. Explain your answer. (2 points)
   False, the expectimax value v_E is an average of child values, so it is possible that by dumb luck the probabilistic opponent chooses a lower value than v_E.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