

COEN 166 Artificial Intelligence

Homework #3 Solution

Guideline: Please complete the following problems and submit the answers as a single PDF file to Camino.

Problem 1: Consider the following game tree in which the utility values (in parentheses at the leaf nodes) are all from the first player's point of view. Assume that the first player is the maximizing player.

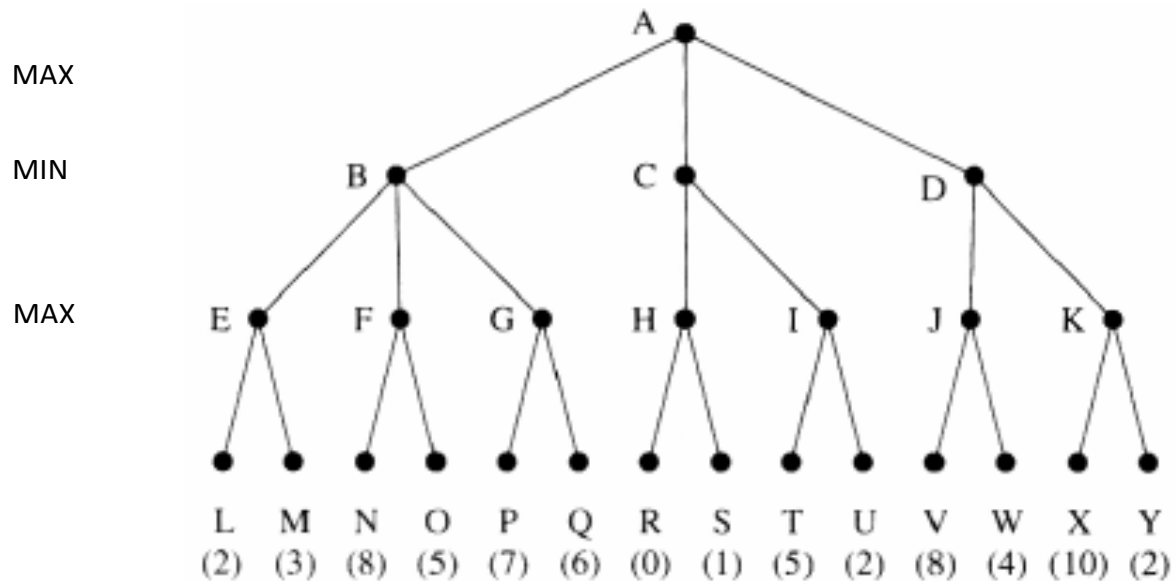


Figure 1.1

- a. What leaf nodes (nodes at the bottom layer) would not need be examined using the alpha-beta pruning algorithm – assuming that the nodes are examined in left-to-right order? Show the derivation procedure on the graph.

Answer: O, Q, T, U, Y

- b. What move should the first player (the root node) choose?

Answer: D

- c. What's the final minimax value of the root node?

Answer: 8

Problem 2: Consider the following search tree.

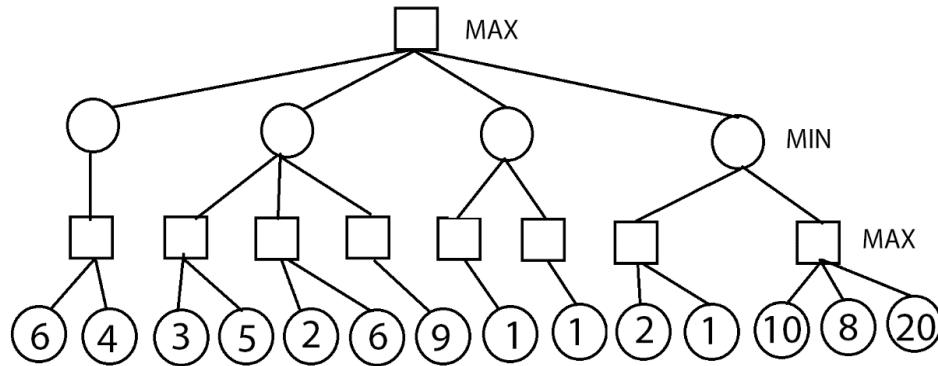


Figure 2.1

- a. Fill in the squares and circles with the backed-up values resulting from a regular minimax search.

Answer: numbers in red in Figure 2.2

- b. What leaf nodes (nodes at the bottom layer) would not need be examined using the alpha-beta pruning algorithm – assuming that the nodes are examined in left-to-right order? Show the derivation procedure on the graph.

Answer: Gray shaded circles in Figure 2.2

- c. What is the minimax value of the root node?

Answer: 6.

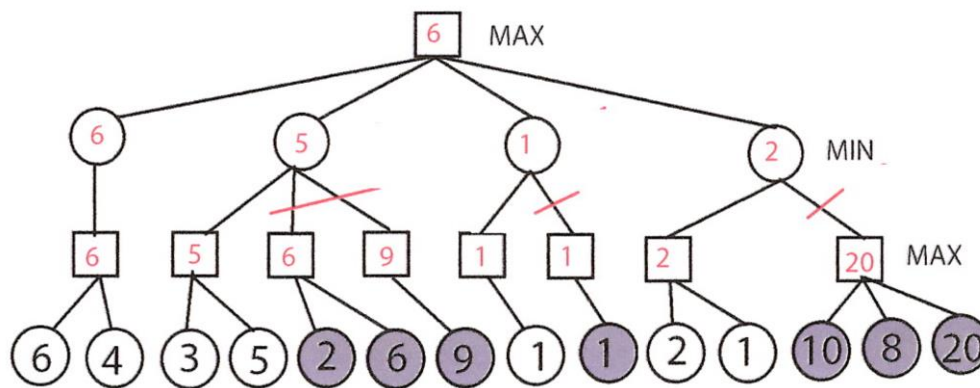
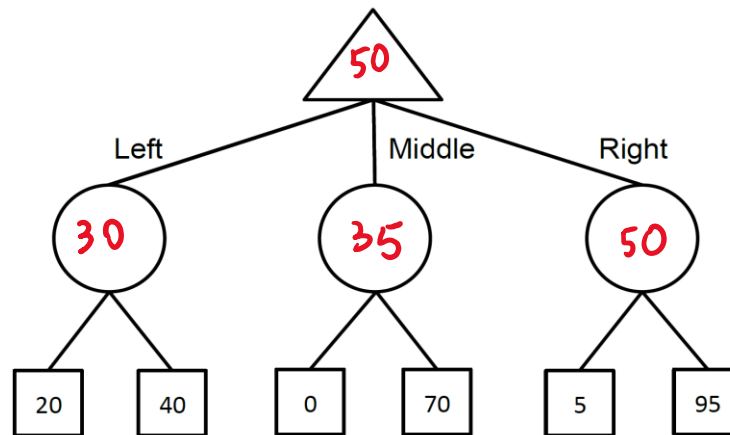


Figure 2.2

Problem 3 Consider the game tree below, where the terminal values are the payoffs of the game. Fill in the expectimax value of each node, assuming that player 1 is maximizing expected payoff and player 2 plays uniformly at random (i.e., each action available has equal probability).



a. What is Player 1's expected payoff if she takes the expectimax optimal action?

Answer: 50

b. Multiple outcomes are possible from Player 1's expectimax play. What is the worst possible payoff she could see from that action?

Answer: 5

c. Even if the average outcome is good, Player 1 doesn't like that very bad outcomes are possible. Therefore, rather than purely maximizing expected payoff using expectimax, Player 1 chooses to perform a modified search. In particular, she only considers actions whose worst-case outcome is 10 or better.

c.1 Which action does Player 1 choose for this tree?

Answer: Left

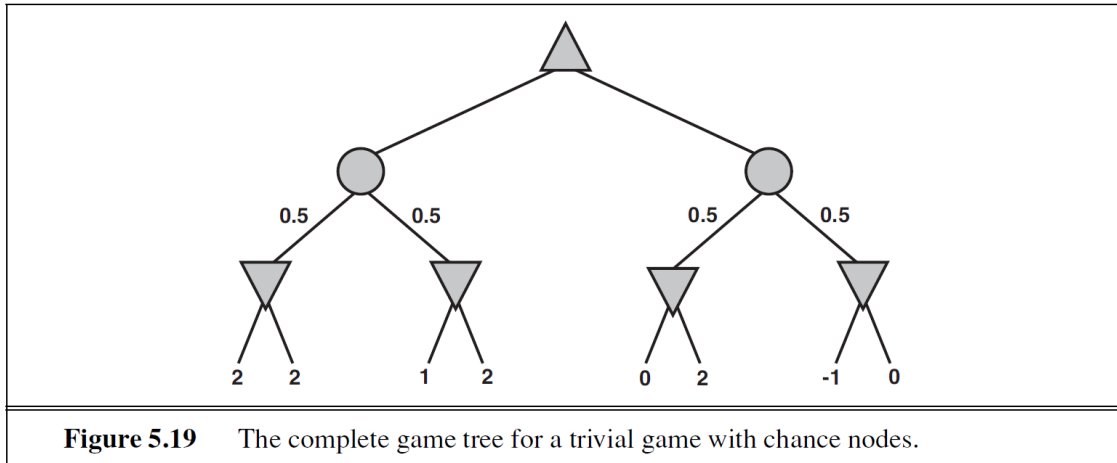
c.2 What is the expected payoff for that action?

Answer: 30

c.3 What is the worst payoff possible for that action?

Answer: 20

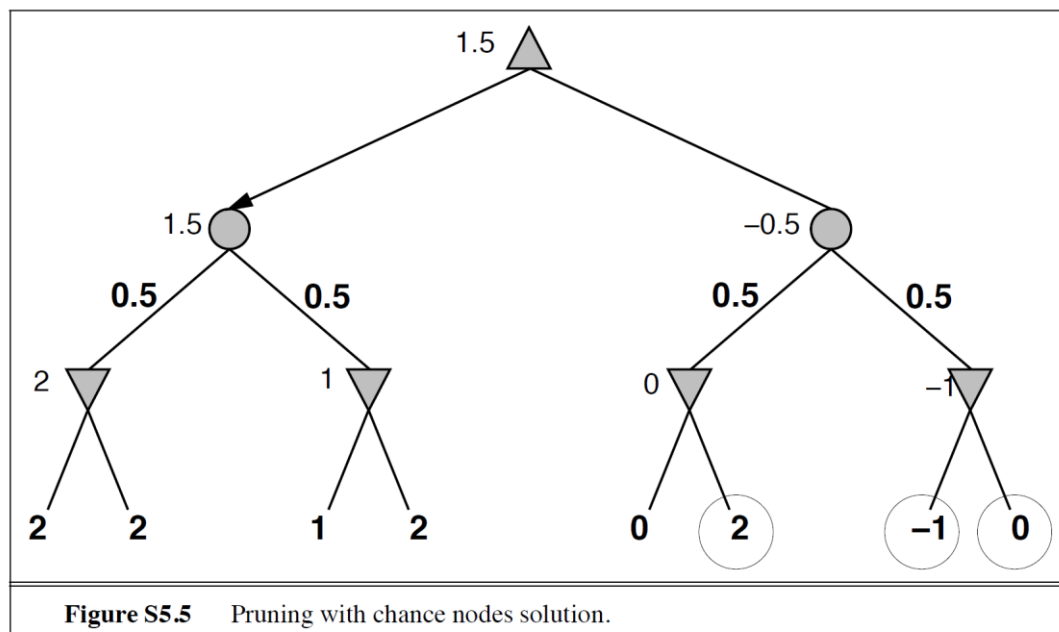
Problem 4 This question considers pruning in games with chance nodes. Figure 5.19 shows the complete game tree for a trivial game. Assume that the leaf nodes are to be evaluated in left-to-right order, and that before a leaf node is evaluated, we know nothing about its value - the range of possible values is $-\infty$ to $+\infty$.



- Copy the figure, mark the value of all the internal nodes, and indicate the best move at the root with an arrow.
- Given the values of the first six leaves, do we need to evaluate the seventh and eighth leaves? Given the values of the first seven leaves, do we need to evaluate the eighth leaf? Explain your answers.
- Suppose the leaf node values are known to lie between -2 and 2 inclusive. After the first two leaves are evaluated, what is the value range for the left-hand chance node?
- Circle all the leaves that need not be evaluated under the assumption in question c.

Answer:

- See Figure S5.5.



- b. Given nodes 1-6, we would need to look at the 7th leaf node. Given nodes 1-7, we do not need to look at 8.
- c. $[0, 2]$.
- d. See Figure S5.5.