CS 5100: Foundations of Artificial Intelligence (Fall 2023) Chris Amato
Student: Bharat Chawla Due October 06, 2023

Adversarial Search

1 Adversarial Search—24 points (6 points each)

1. Suppose you have an oracle, MO(s), that correctly predicts the opponent's move in any state. Using this, formulate the definition of a game as a (single-agent) search problem. Describe an algorithm for finding the optimal move.

2. Which of the following are true and which are false? Give **brief** explanations.

   (a) In a partially observable, turn-taking, zero-sum game between two perfectly rational players, it's helpful for the first player to know what strategy the second player is using—that is, what move the second player will make, given the first player's move.

   (b) In a fully observable, turn-taking, zero-sum game between two perfectly rational players, it does not help the first player to know what move the second player will make, given the first player's move.

   (c) A perfectly rational backgammon agent never loses.

2 Minimax—24 points (6 points each)

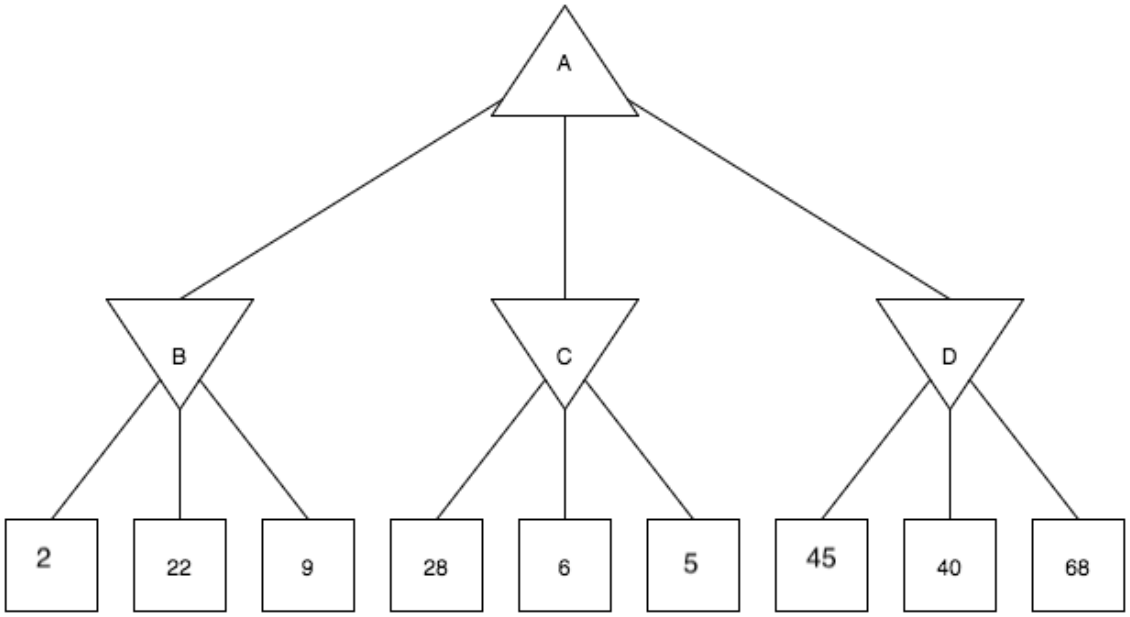

Figure 1: Minimax

(a) For the Minimax tree above, what is the value of A,B,C,D?

The algorithm first recurses down to the three bottom-left nodes and uses the utility function on them to discover that their values are 2,22, and 9 respectively. Then it takes the minimum of these values, 2, and returns it as the backed up value for node B.
A similar process gives the backed-up values of 5 for C and 40 for D. Finally, we take maximum of 2,5, and 40 to get the backed-up value of 40 for the root node i.e. A.

A: 40
B: 2
C: 5
D: 40

3 Alpha-Beta Pruning—31 points

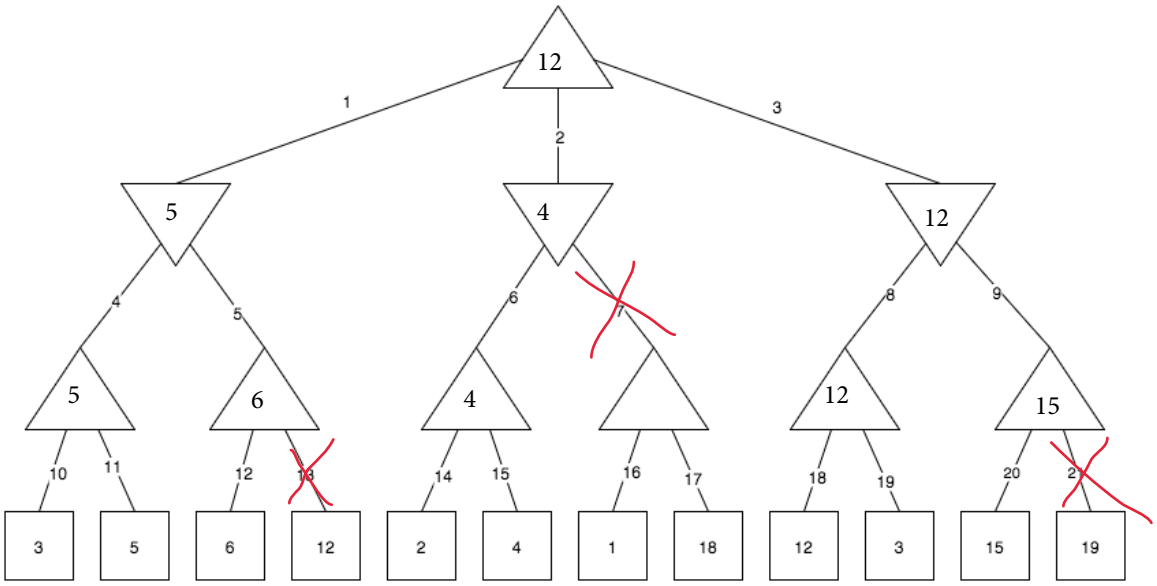

Figure 2: Alpha-Beta Pruning

Please fill in the state's utility values for the game tree above using alpha-beta pruning, cross the pruned edges and write down the Alpha Beta value *from the parent state to the child state*. Use the number on the edge as the identifier in the table below. You don't need to write Alpah-Beta values for the edges that have been pruned and the utility values for the pruned states.

	Alpha	Beta
1	$-\infty$	$+\infty$
2	5	$+\infty$
3	5	$+\infty$
4	$-\infty$	$+\infty$
5	$-\infty$	5
6	5	$+\infty$
7		
8	5	$+\infty$
9	5	12
10	$-\infty$	$+\infty$

	Alpha	Beta
11	3	$+\infty$
12	$-\infty$	5
13		
14	5	$+\infty$
15	5	$+\infty$
16		
17		
18	5	$+\infty$
19	12	$+\infty$
20	5	12
21		

4 Expectimax–21 points (3 points each)

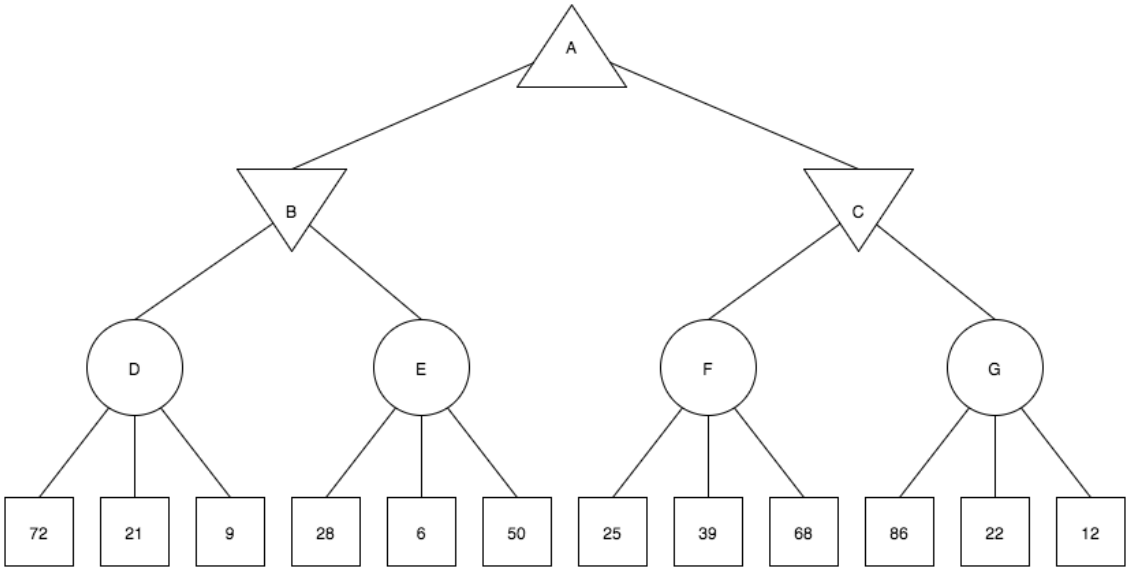

Figure 3: Expectimax

For the Expectimax tree above, what is the value of A,B,C,D,E,F,G? (Assume uniform random probabilities)

A: 40

B: 28

C: 40

D: (1/3) * (72 + 21 + 9) = 34

E: (1/3) * (28 + 6 + 50) = 28

F: (1/3) * (25 + 39 + 68) = 44

G: (1/3) * (86 + 22 + 12) = 40