AI-Assignment#5 (Game Playing)

1) Recall the game of **Nim** that we played in class. Initially, there are k piles, each containing n_k sticks. Two players alternate turns, and at each turn the current player removes any positive number of sticks from one of the piles. At least one stick must be removed during a turn. The last player to remove a stick loses. We will represent a state in this game as a k+1-tuple: **$[s_1 \ldots s_k\ p]$**, where s_i is in the interval $[0,n_k]$, and represents the number of sticks remaining in pile i; and p is either A (MAX) or B (MIN), representing which player's move is next.

A) For this problem, you will be considering Nim211, a variation of Nim with three piles, one containing two sticks, and the others each containing one stick. Player A goes first, so the initial state is [211A].

a.1) <u>Game Tree</u>

Draw the complete game tree for Nim211. The left-to-right order of actions taken should always be: remove 1 stick from pile 1, remove 2 sticks from pile 1, remove 1 stick from pile 2, and remove 1 stick from pile 3. (Obviously you should only have branches for actions that are legal in a particular state.) We will ignore the issue of repeated states for this problem, so it's OK if a state appears in more than one place in your tree.

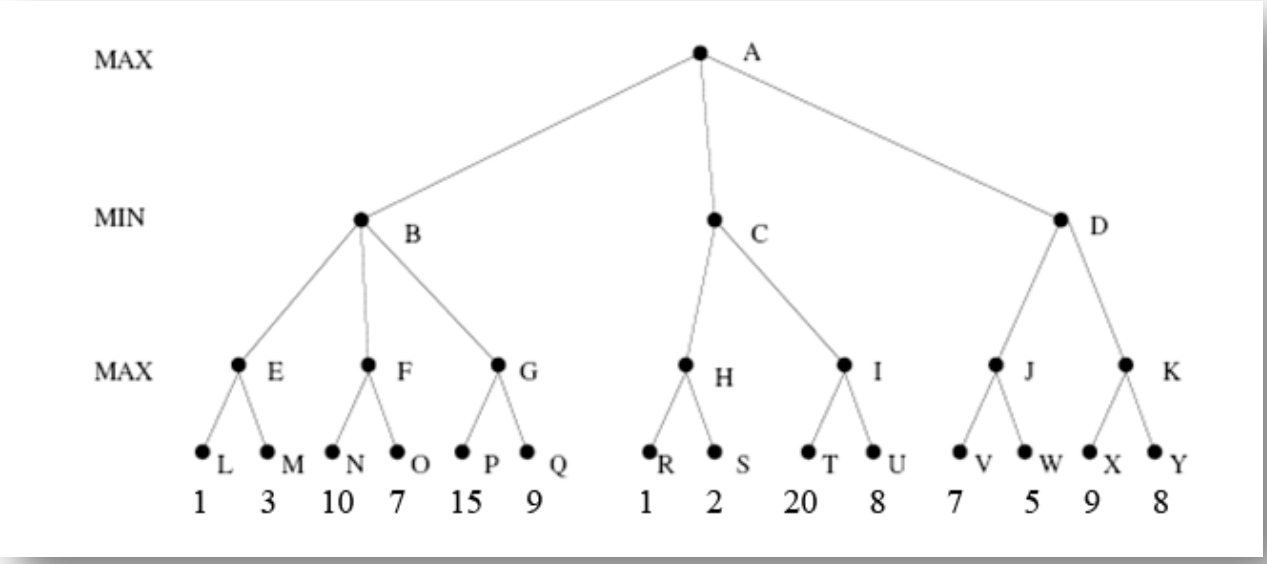
a.2) <u>Minimax and Alpha-Beta</u>

(i) Mark the terminal nodes in the game tree you drew for Question A.1 with their utility values, using +1 to indicate a win for A (MAX), and -1 to indicate a win for B (MIN).

(ii) Annotate each of the nodes in the tree with its backed-up minimax value.

(iii) Circle the nodes that would be pruned by alpha-beta pruning using depth-first (left-to-right) search. (You should assume that the alpha values are initialized to -1, rather than -infinity, and that the beta values are initialized to +1, rather than +infinity.

B) Now, you will be considering Nim6, a variation of Nim with only one pile, yes… one containing six sticks. At least one stick or two stick must be removed during a turn. Player A goes first, so the initial state is [6A]. By using the same techniques (Game Tree, Minimax and Alpha-Beta) in question A, how do you conclude for this case?



2) Consider the game search tree in the figure above.

Assume the first player is the max player and the values at leaves of the tree reflect his/her utility. The opponent wants the same utility to be minimized.

a) Compute the Minimax values for each node in the tree? What move should the first player choose? What is the solution path the rational players would play?

b) Assume we use alpha-beta algorithm to explore the game tree and we do this in the left-to-right order and determine the players' strategies. List all nodes that are cut off from the tree and are never examined by the alpha-beta procedure.

c) Assume we use alpha-beta algorithm but explore the tree in the right-to-left order. What nodes would not need to be examined by the alpha-beta algorithm and pruned away?

3) Consider a non-zero sum game below between Player 1 and Player 2, is there any Nash equilibrium in this game?, if there is one, please identify it.

		Player 2		
		L	C	R
Player 1	U	1,1	2,0	2,2
	M	0,3	1,5	4,4
	D	2,4	3,6	3,0