1 Game Tree Search
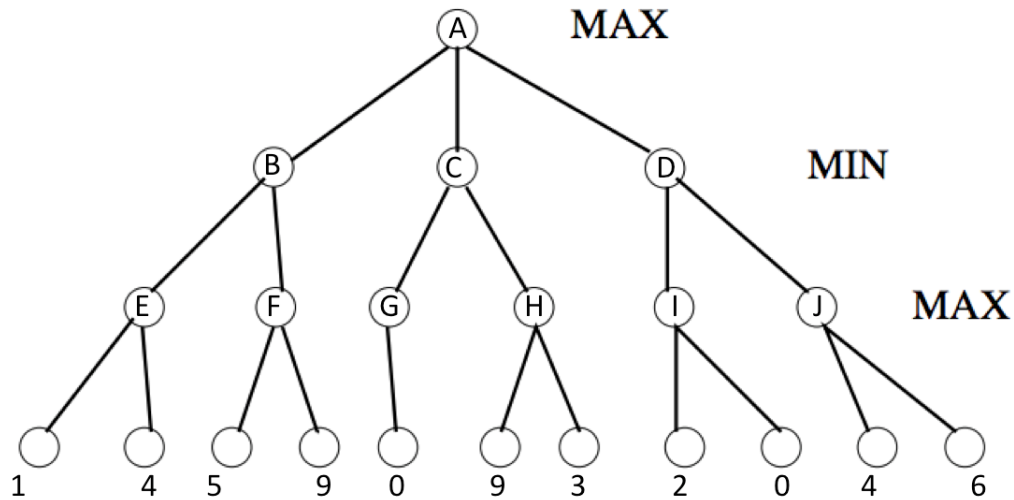
1. Consider the following game tree, where the utility of each terminal node is specified.

   (a) For each min and max node, list its minimax value in the space below (one mark off for each incorrect answer):

A	B	C
D	E	F
G	H	I
J		

   (b) On the diagram, put a check besides the nodes that will be visited during a minmax depth-first search that uses *alpha-beta* pruning. You should also mark any terminal node that is visited. Draw a line across each edge that leads to a sub-tree pruned by an alpha or beta bound.

   (c) What value does player MAX expect to get out of the game if MIN plays perfectly?

   (d) What value does player MAX expect to get out of the game if MIN always moves to state E from state B?

   (e) What value does player MAX expect to get out of the game if MIN always moves to state F from state B?

2. What is the difference in the definition of a heuristic value for a game state, and for a state in A* search? What properties make a heuristic in either situation 'good'?

3. Assume you have come up with a minimax policy after traversing to all the terminals of a game tree. Someone then comes along and doubles the value of every terminal over some threshold. Will you come up with the same policy if you run minimax again? What if someone doubles only values of terminals that are even?

4. Why is minimax search generally not used to play real games? from left to right, the leftmost branch will never be pruned.

5. **True or False:** The alpha-beta algorithm will always result in at least one branch of the game tree being pruned.

6. Consider a game tree constructed for an Othello 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?

    (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?

7. **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.