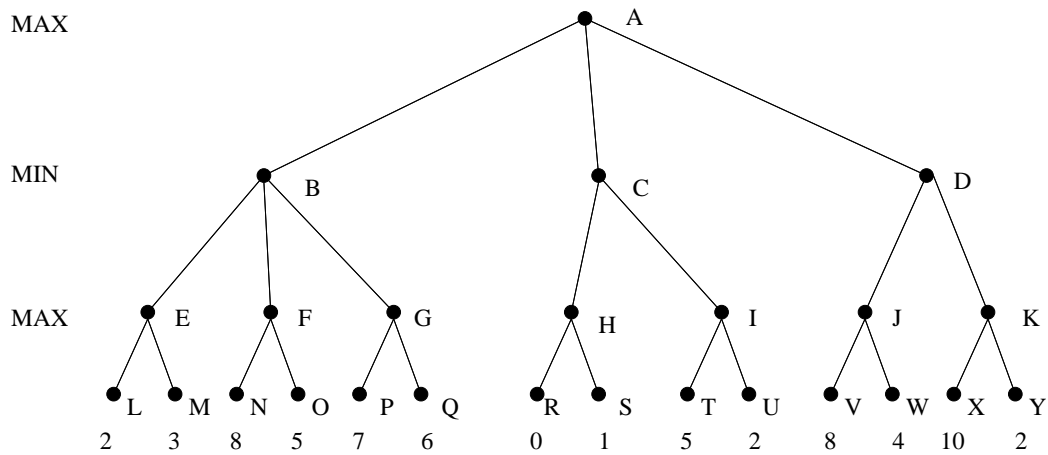

Solutions to problem set 4

Problem 1. Adversarial search

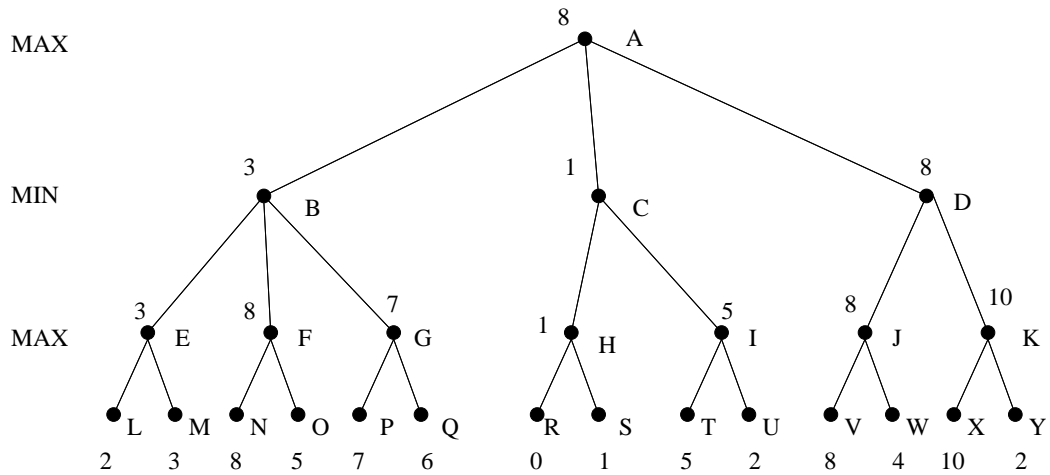
Consider the game search tree in the figure below



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.

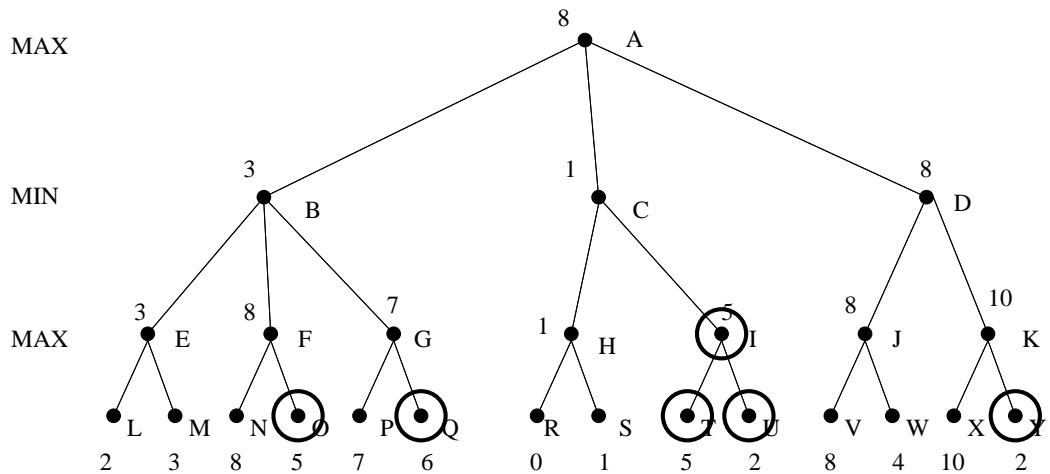
Part a. Compute the minimax values for each node in the tree? What move should the first player choose? What is the solution path the rational players would play.

Answer. The figure below shows the minimax values for the game tree. The MAX player should choose option D since this is the option that leads to the highest value.



Part b. Assume we use alpha-beta algorithm to explore the game tree and we do this in 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.

Answer. The nodes never examined during alpha-beta algorithm are : O,Q, I,T,U,Y, and are circled below.



The reason for not examining the nodes is that they are pruned before they are searched and evaluated. For example, O can be pruned away since the MIN player at node B can always achieve smaller values by choosing E (with value 3) than it can ever achieve through F. This is detected early after examining only node N, since choice of N guarantees the value of at least 8 at F. Thus, there is no need to examine other successors of F, in our case node O, if we proceed from left to right.

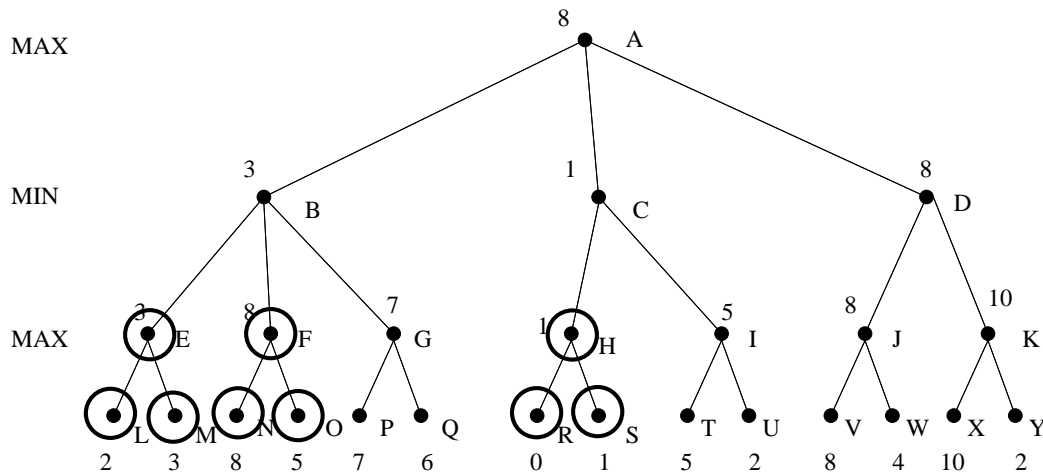
Similar situation occurs in the case of Q. Since the min player at B can achieve 3 by choosing E and the maximizer at G can achieve at least 7 (at P), there is no need to examine Q since MIN player at B would never choose G under the rational strategy.

The other pruning occurs at A when the MAX player can achieve at least 3 by choosing B, while choosing C would lead to value of at most 1. The fact that value is at most 1 is determined early after evaluating R,S,H nodes and thus I,T,U are never examined by the alpha-beta pruning that proceeds from left to right.

The reason for early pruning of Y is similar to the first two cases. MIN player at D determines it cannot achieve better (smaller) value by playing K as compared to J. The reason is that the value at K is at least 10, and J provides better option.

Part 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?

Answer. The nodes never examined during alpha-beta algorithm (in the right-to-left search) are : E,L,M,N,O,F,H,R,S and are circled below.



Problem 2. Tic-tac toe

This was an open ended problem with no single correct answer.

Part a, b. One example program is posted. Please study it critically.

Part c. Congratulation to the winner!