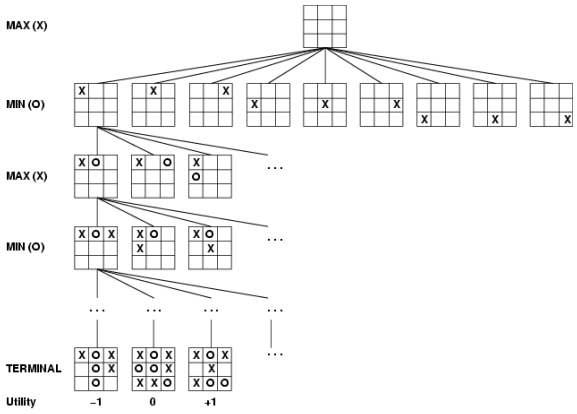
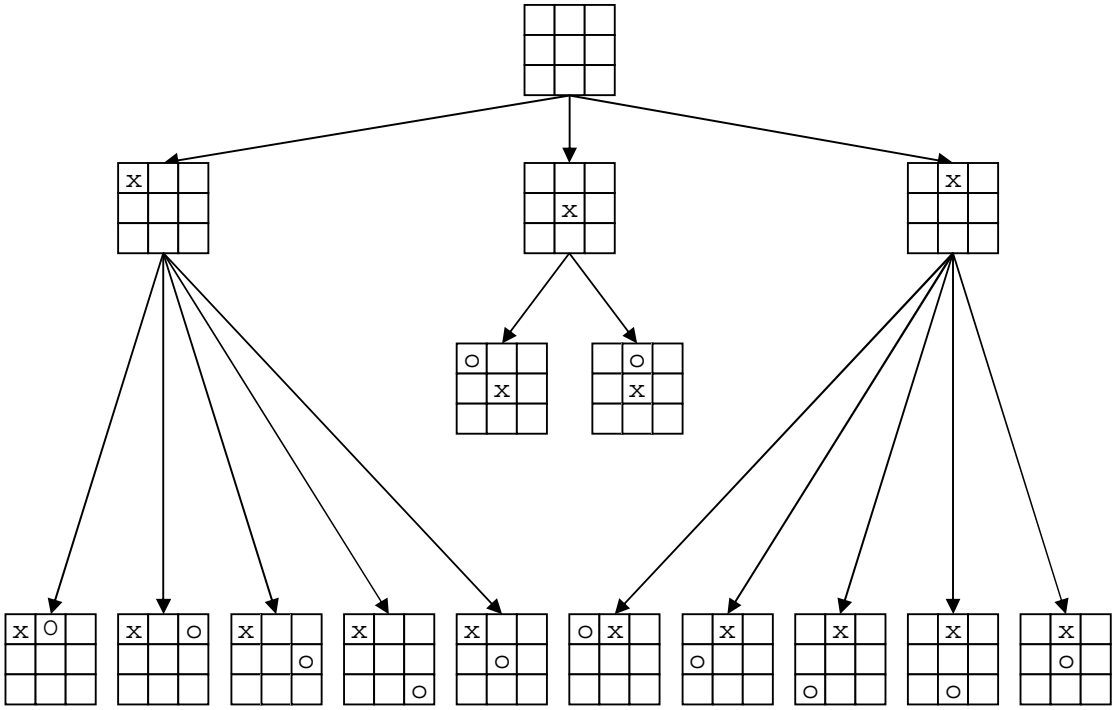
CS3243 Foundations of Artificial Intelligence (2005/2006 Semester 2)
Tutorial 4

1. Referring to Figure 6.1 in the textbook, reproduced at the right, the Tic-Tac-Toe search space can actually be reduced by means of symmetry. This is done by eliminating those states which become identical with an earlier state after a symmetry operation (e.g. rotation). The following diagram shows a reduced state space for the first three levels with the player making the first move using "x" and the opponent making the next move with "o". Assume that the following heuristic evaluation function is used at each leaf node n:

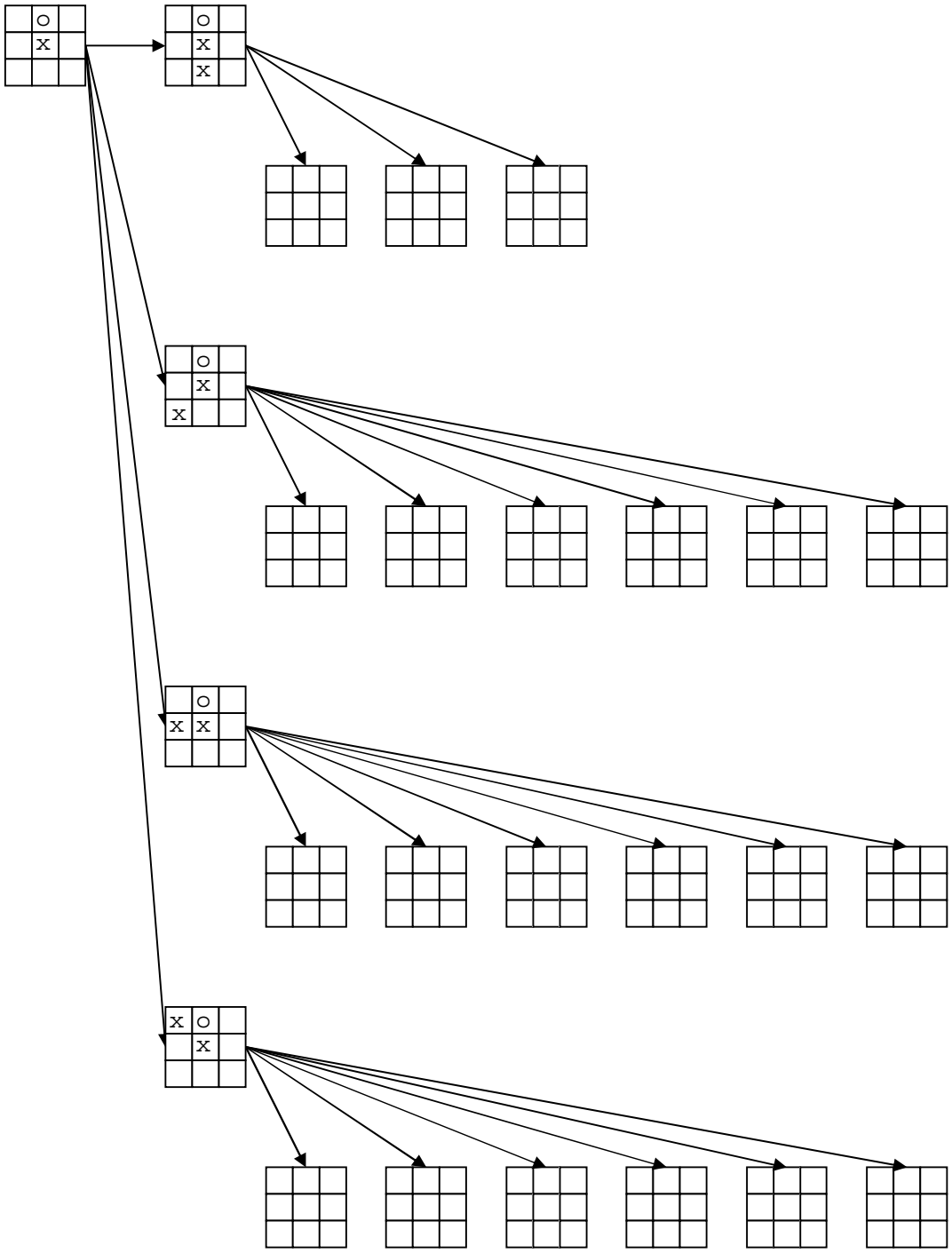


Eval(n) = P(n) - O(n)

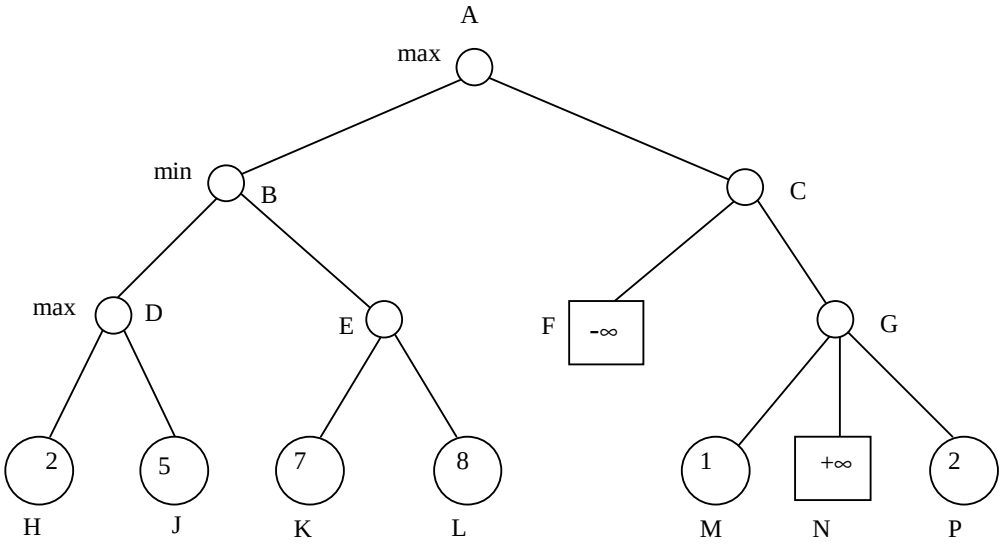
where P(n) is the no. of winning lines for the player while O(n) is the no. of winning lines for the opponent. A winning line for the player is a line (horizontal, vertical or diagonal) that either contains nothing or "x". For the opponent, it is either nothing or "o" in the winning line. Thus, for the leftmost leaf node in the following diagram, Eval(n) = 6 - 5 = 1. Now use the minimax algorithm to determine the first move of the player, searching 2-ply deep.



2. Continue from the above question, assume that the “x” player will now make his second move after his opponent has placed an “o”. Complete the following minimax tree by filling the remaining blank boards at the leaf nodes. Compute the evaluation function for each of the filled leaf nodes and determine the second move of the “x” player (searching 2-ply deep).



3. The following minimax search tree has heuristic evaluation function values with respect to the max player for all the leaf nodes, where square leaf nodes denote end of game with +∞ representing that the max player wins the game and -∞ representing that the min player is the winner. Do a minimax search and determine the next move of the max player from node A. Which is the target leaf node that the max player hopes to reach?



4. Suppose we use alpha-beta pruning in the direction from left to right to prune the search tree in question 3. Indicate which arcs are pruned by the procedure. Do you get the same answer in terms of the max player's next move and target leaf node?