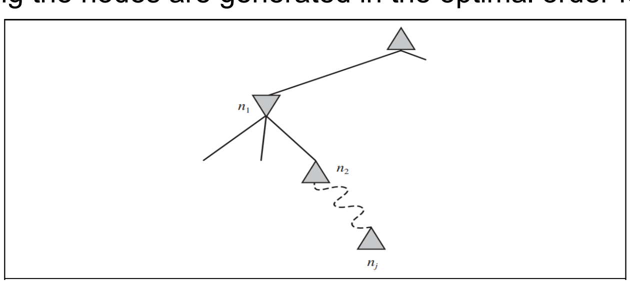
The Hebrew University of Jerusalem Introduction to Artificial Intelligence Problem Set 2- Adversarial search & logic

Adversarial search

[25 points]
1. Using the definitions of MIN and MAX functions from the minimax algorithm learned in class Prove the following assertion:
For every game tree, the utility obtained by MAX using minimax decisions against any other min strategy will never be lower than the utility obtained playing against MIN.
Find a game tree and a min function in which max player can do better using a different staterge (than using MAX).
(Draw the game tree and explain the strategies of min and max)

[30 points]
2. This problem exercises the basic concepts of game playing, using tic-tac-toe (noughts and crosses) as an example. We define Xn as the number of rows, columns, or diagonals with exactly n X's and no O's. Similarly, On is the number of rows, columns, or diagonals with just n O's. The utility function assigns +1 to any position with X3 = 1 and -1 to any position with O3 = 1. All other terminal positions have utility 0. For nonterminal positions, we use a linear evaluation function defined as Eval(s) =$3X_2(s) + X_1(s) - 3O_2(s) - O_1(s)$

a. Approximately how many possible games of tic-tac-toe are there?
b. Show the whole game tree starting from an empty board down to depth 2 (i.e., one X and one O on the board), taking symmetry into account.
c. Mark on your tree the evaluations of all the positions at depth 2.
d. Using the minimax algorithm, mark on your tree the backed-up values for the positions at depths 1 and 0, and use those values to choose the best starting move.
e. Circle the nodes at depth 2 that would not be evaluated if alpha–beta pruning were applied, assuming the nodes are generated in the optimal order for alpha–beta pruning.



[20 Points]
Adversarial Search Problem 3 :
Find the max-min binary game tree with 4 terminal states with utilities {1, 2, 3, 4}-values in the nodes that achieves the most effective alpha-beta pruning. (The tree does not have to be balanced).

Logic

[25 points]
1. Convert the following formulae into Conjunctive Normal Form (CNF).
   a. $Q \rightarrow P$
   b. $(P \rightarrow \neg Q) \rightarrow R$
   c. $\neg(P \land \neg Q) \rightarrow (\neg R \lor \neg Q)$
   d. $\neg (P \rightarrow \neg Q) \rightarrow R$
   e. $\neg (P \rightarrow (\neg R \lor \neg Q)) \rightarrow \neg R$