

ICS 271  
 Fall 2016  
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 Homework Assignment 3  
 Due Tuesday, 10/25

1. (a)  $< 3^9$   
 (b) Depth of the tree = 9 (excluding root node)  
 Does the complete game tree contain all the board positions you counted in (a)? No, eg. 'less  $\bigcirc$  than  $\times$ ' will not appear in the tree.  
 Does it contain additional board positions? No.  
 (c) See figure below.  
 (d) See figure below. (Same figure with (c))  
 (e)  
 2. Yes. The game tree is complete, so alpha-beta pruning algorithm is guaranteed to force a win.
3. (a) Fourth node from left to right.  
 (b) node 1,2,3,4,5
4. If  $a > 0$ , then we have

$$\min(5ax_1 + b, 5ax_2 + b, \dots, 5ax_n + b) = 5a \min(x_1, x_2, \dots, x_n) + b$$

$$\max(5ax_1 + b, 5ax_2 + b, \dots, 5ax_n + b) = 5a \max(x_1, x_2, \dots, x_n) + b$$

That means the linear transformation ( $a > 0$ ) of leaf nodes would not affect the value of parent node. Maximum or minimum choice would not change.

5. Take the average over all  $n$  executions is Monte Carlo method. According to **Strong Law of Large Numbers**,

$$\frac{1}{n} \sum_{i=1}^n x_i \xrightarrow{n \rightarrow \infty} \mathbf{E}(\mathbf{X}), x_i \in \mathbf{X}$$

The average of more samples lead to the true expected value.