ICS 271
Fall 2016
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Instructor : Kalev Kask
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 ◯ than ×' will not appear in the tree.
   Does it contain additional board positions? No.
   (c) See Figure 1.
   (d) See Figure 1.
   (e) See Figures 2-4.

2. Yes. The game tree is complete, so alpha-beta pruning algorithm is guaranteed to force a win.

3. (a) First node from left to right. (See Figure 5)
   (b) See Figure 5.

4. If $a > 0$, then we have

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

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

   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**,

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

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

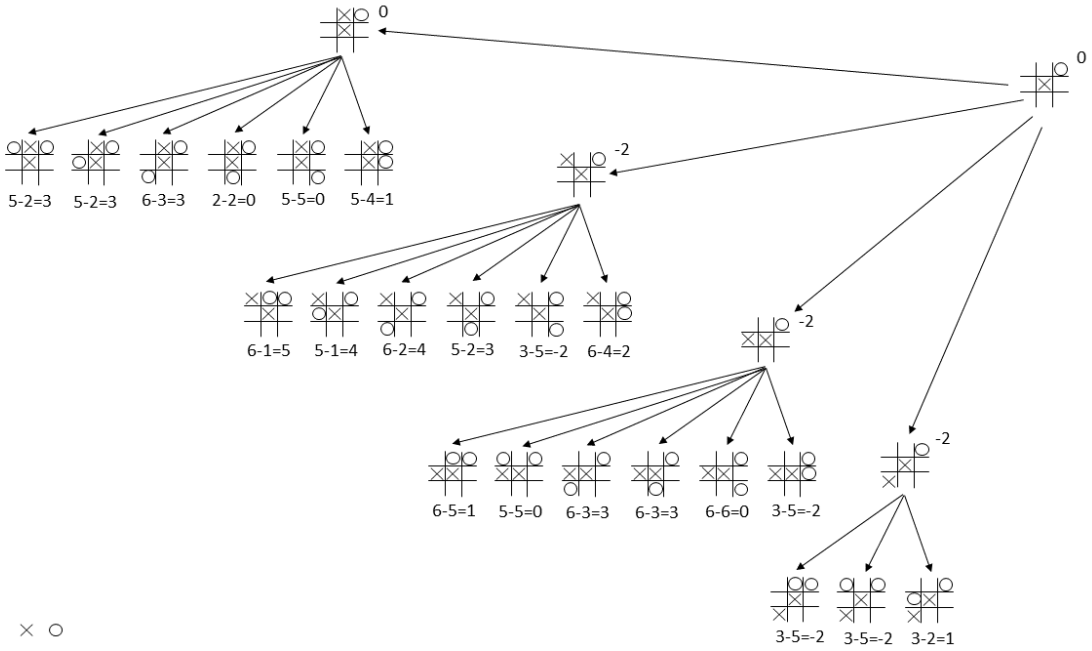

Figure 1:

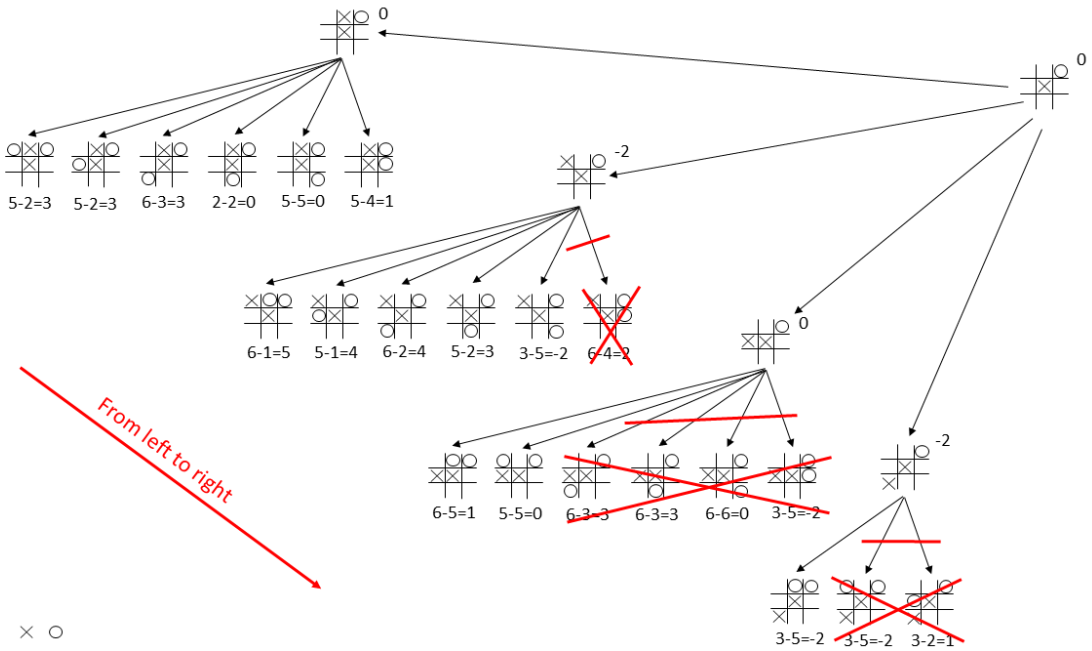

Figure 2:

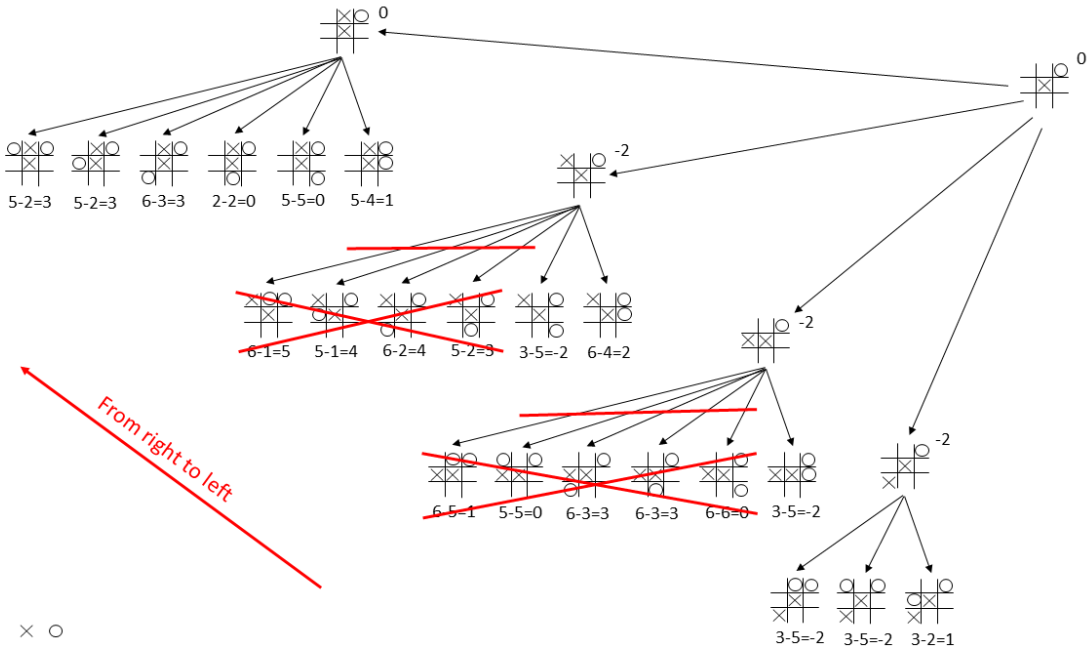

Figure 3:

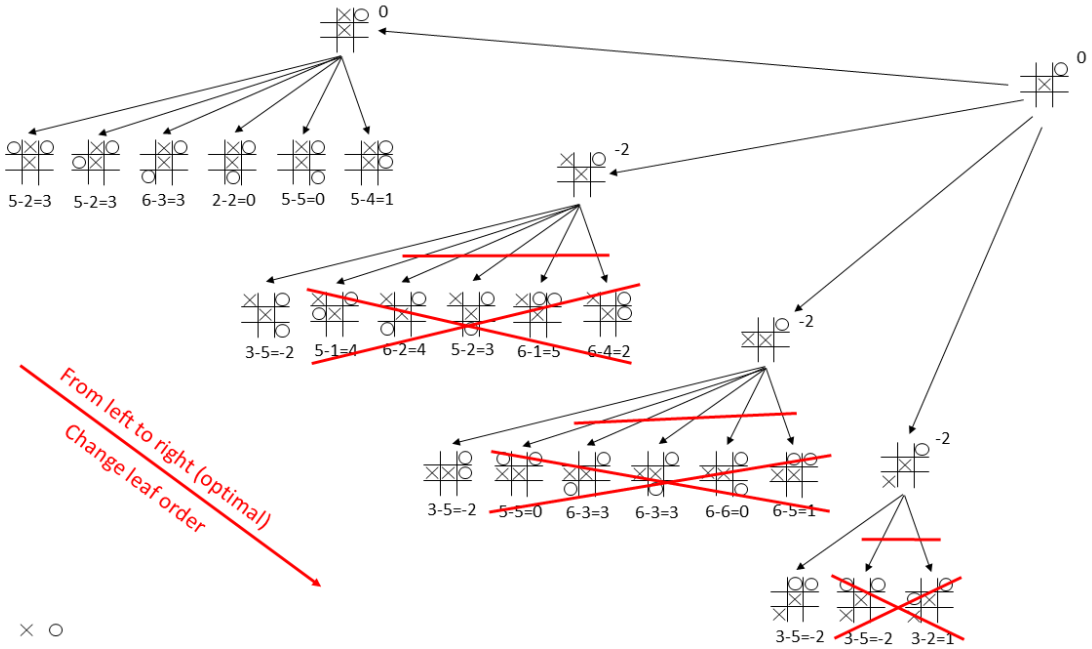

Figure 4:

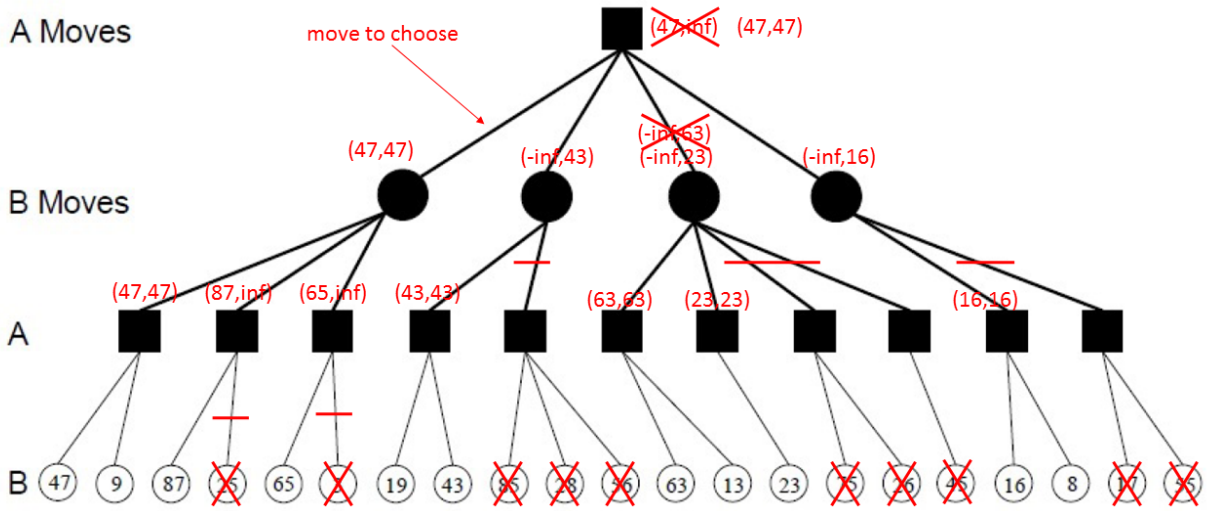
A Moves
move to choose
(47,47)
(47,47)
B Moves
(47,47)
(-inf,43)
(-inf,23)
(-inf,16)
(47,47)
(87,inf)
(65,inf)
(43,43)
(63,63)
(23,23)
(16,16)
A
B
47
9
87
65
19
43
63
13
23
16
8

Figure 5: