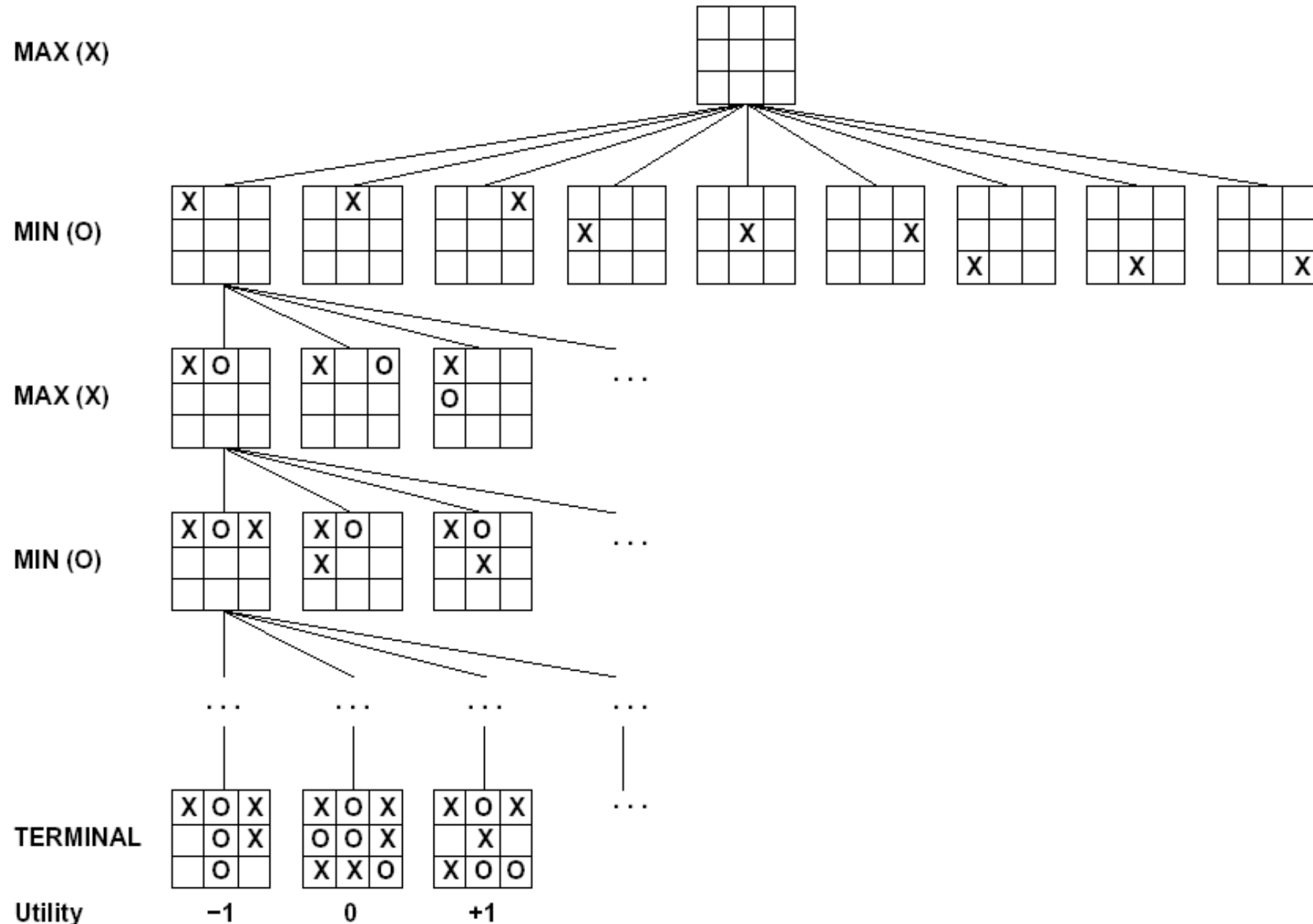


- Evaluation-Function
- Alpha-Beta-Pruning
- Monte-Carlo Tree Search



(Number of own chances to win) – (number of opposite chances)

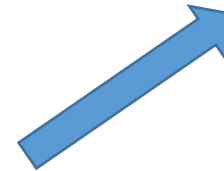
	X	

$$8 - 4 = 4$$



O		
	X	

$$5 - 4 = 1$$



X	O	
	X	

$$6 - 2 = 4$$

X		

$$8 - 5 = 3$$

	O	
	X	

$$6 - 4 = 2$$

	O	
X	X	

$$6 - 3 = 3$$

	X	

$$8 - 6 = 2$$

Improvement (idea similar to Quiescence Search):

If: Immediate-Win then 100

elseif: Double-Double then 10

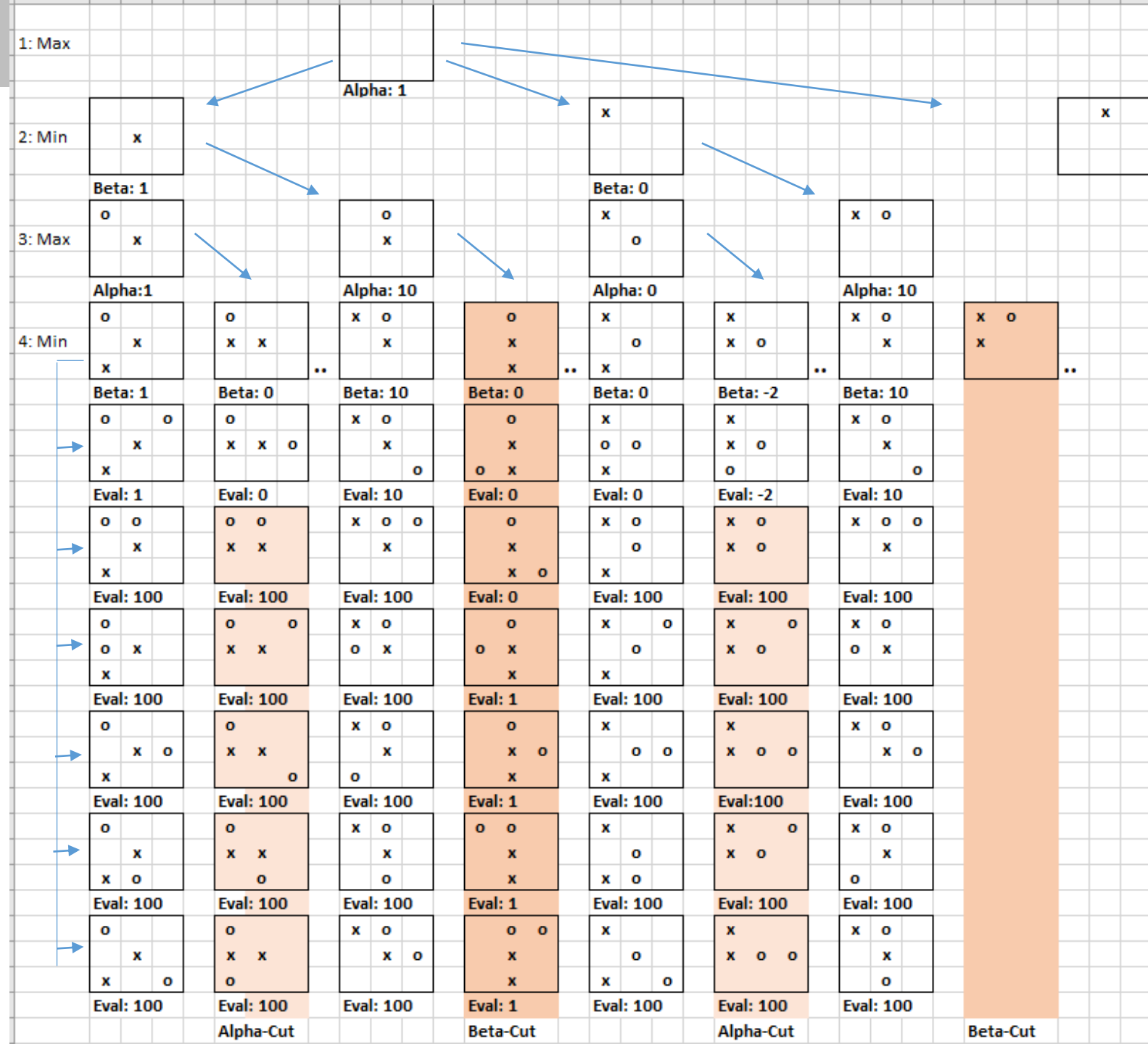
else: (Number of own chances to win) – (number of opposite chances)

X	O	
X	X	
		O



Example

- ... for Alpha-Cut (light orange)
- ... for Beta-Cut (full orange)
- With search depth of 4



Monte Carlo Tree Search

function MONTE-CARLO-TREE-SEARCH(*state*) **returns** *an action*

tree ← NODE(*state*)

while IS-TIME-REMAINING() **do**

leaf ← SELECT(*tree*)

child ← EXPAND(*leaf*)

result ← SIMULATE(*child*)

 BACK-PROPAGATE(*result*, *child*)

return the move in ACTIONS(*state*) whose node has highest number of playouts

Selection strategy:

$$UCB1(n) = \frac{U(n)}{N(n)} + C \times \sqrt{\frac{\log N(\text{PARENT}(n))}{N(n)}}$$

U(n) = Utility of node **n**

N(n) = Number of visits

C = Constant, e.g. $\sqrt{2}$

U(n) = # Wins

o		
	x	
x		
2,5 from 4		

$$\begin{aligned} 5/8 + \sqrt{2} \cdot \sqrt{(\log 5/4)} &\approx \\ 0,625 + 1,4 \cdot 1,6/4 &\approx \\ 0,625 + 0,56 &\approx \mathbf{1,2} \end{aligned}$$

o		
x	x	
0 from 1		

$$\begin{aligned} 0 + \sqrt{2} \cdot \sqrt{(\log 5/1)} &\approx \\ 0 + 1,4 \cdot 1,6/1 &\approx \\ 0 + 2,24 &\approx \mathbf{2,2} \end{aligned}$$

Artificial Intelligence 1

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blue area: playout
(no counts, no memory)

4

blue area: playout
(no counts, no memory)

