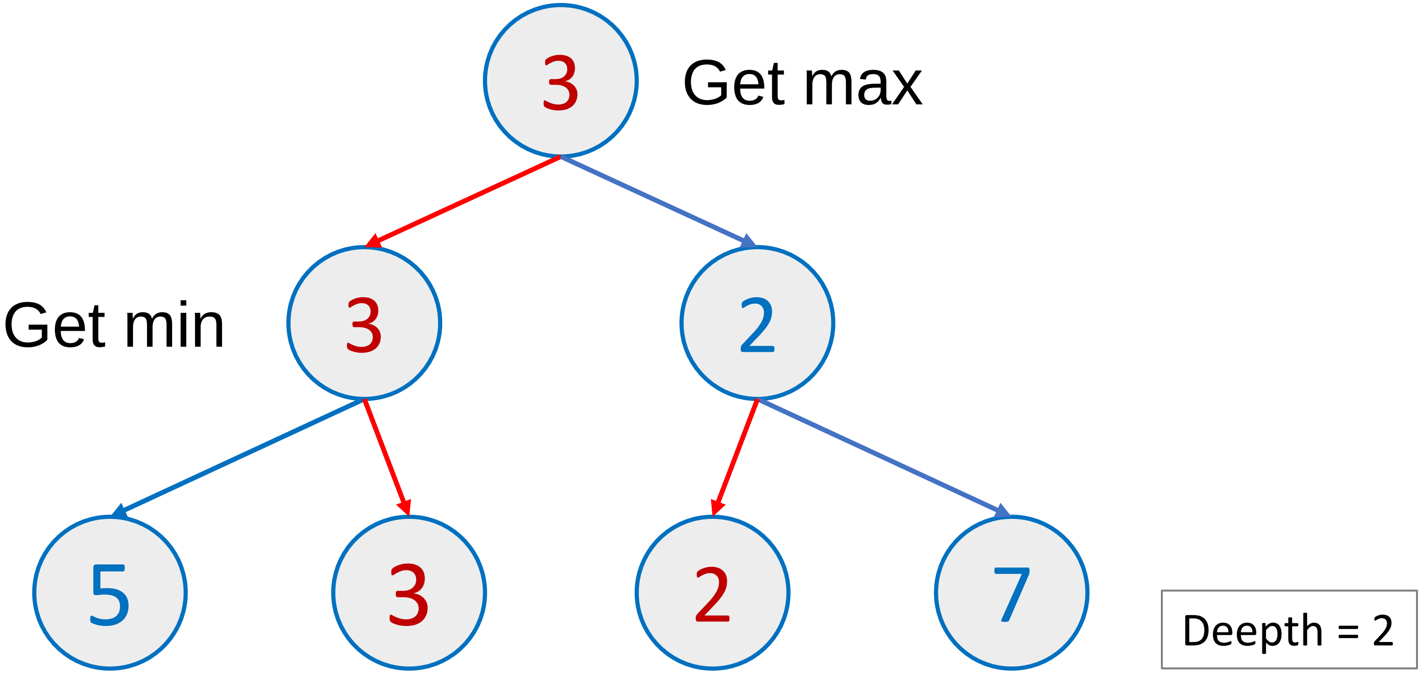
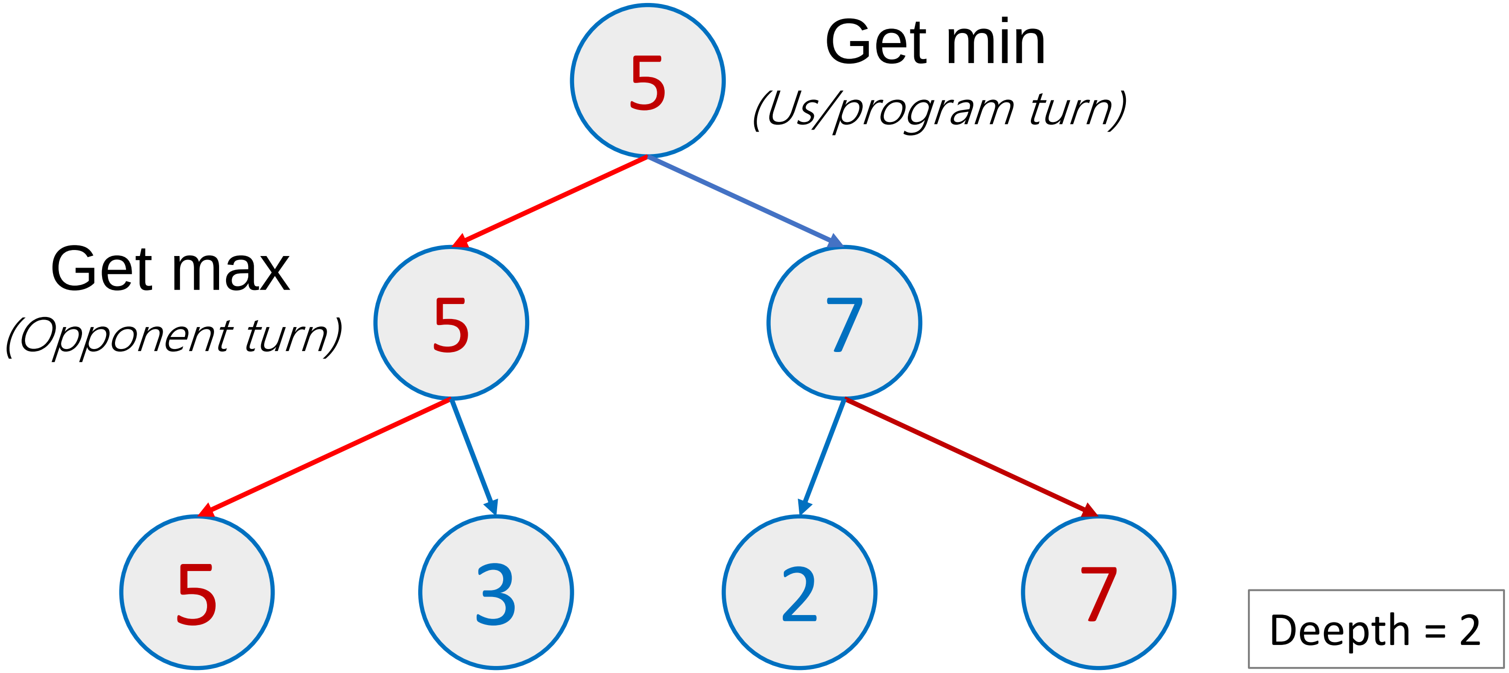
MiniMax Algorithm

- MiniMax algorithm help us/program make a decision which is the best move in all of state can happen.
- To basically, the whole algorithm is divided into two-phase. Get max and get min from children of each state.



MiniMax Algorithm

- When we combine this algorithm with Adversarial Search, we must predict our's opponent move. Suppose they always select the best move for them. So, we change our algorithm a little bit.



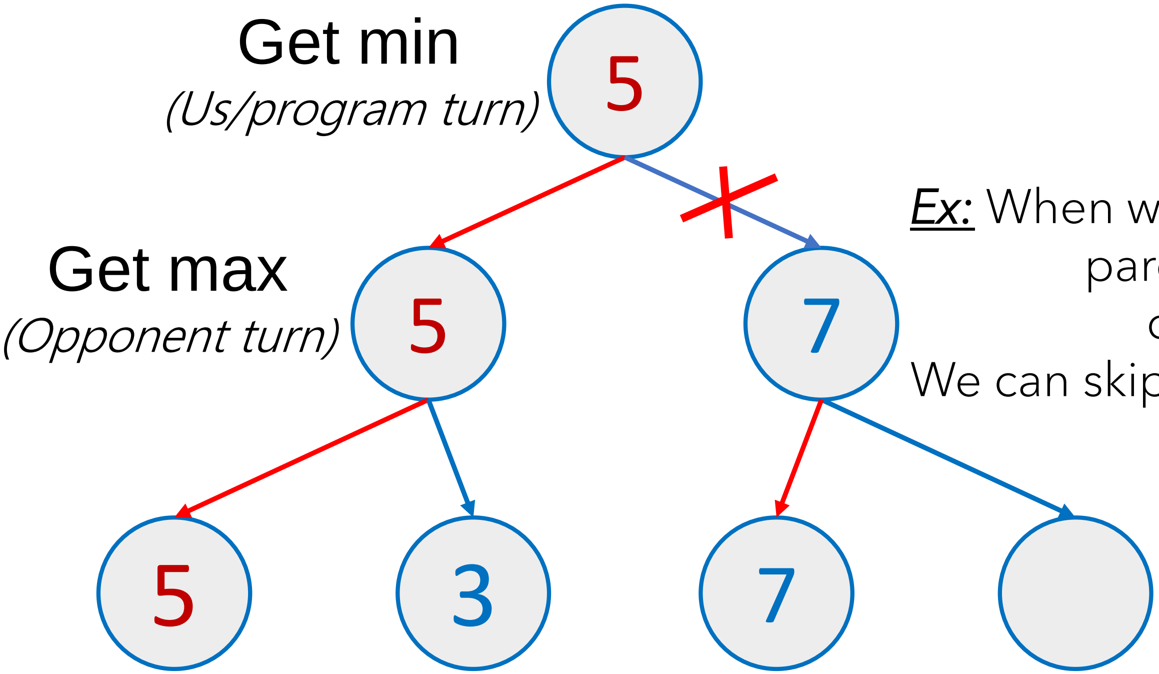
MiniMax Algorithm

Pseudocode

```
def mini_max(crr_state, deepth, turn):
    if deepth == 1:
        return get_max_benefit(crr_state)
    else:
        best_move = None
        crr_benefit = 1000#if deepth is odd, 0 if not
        for move in can_move(crr_state, turn):
            get_benefit = mini_max(move, deepth - 1,
                                     change_turn)
            if get_benefit > crr_benefit and
             deepth%2==1 or get_benefit < crr_benefit
             and deepth%2==0:
                crr_benefit = get_benefit[1]
                best_move = move
        return best_move, crr_benefit
```

Alpha-beta Pruning

- Alpha-Beta pruning is an optimization technique for MiniMax algorithm.
- It will cut off all states that no longer necessary to calculate.



Get min

(Us/program turn)

Get max

(Opponent turn)

__Ex:__ When we get 7 and we know parent node is get min and current node is get max. We can skip all node of that branch

Deepth = 2

MiniMax and Alpha-beta Pruning

Pseudocode

```
def mini_max(crr_state, deepth, turn, tgt_benefit):
    if deepth == 1:
       return get_max_benefit(crr_state, tgt_benefit)
    else:
    # The rest of the pseudocode in the next slide
```

MiniMax and Alpha-beta Pruning

Pseudocode

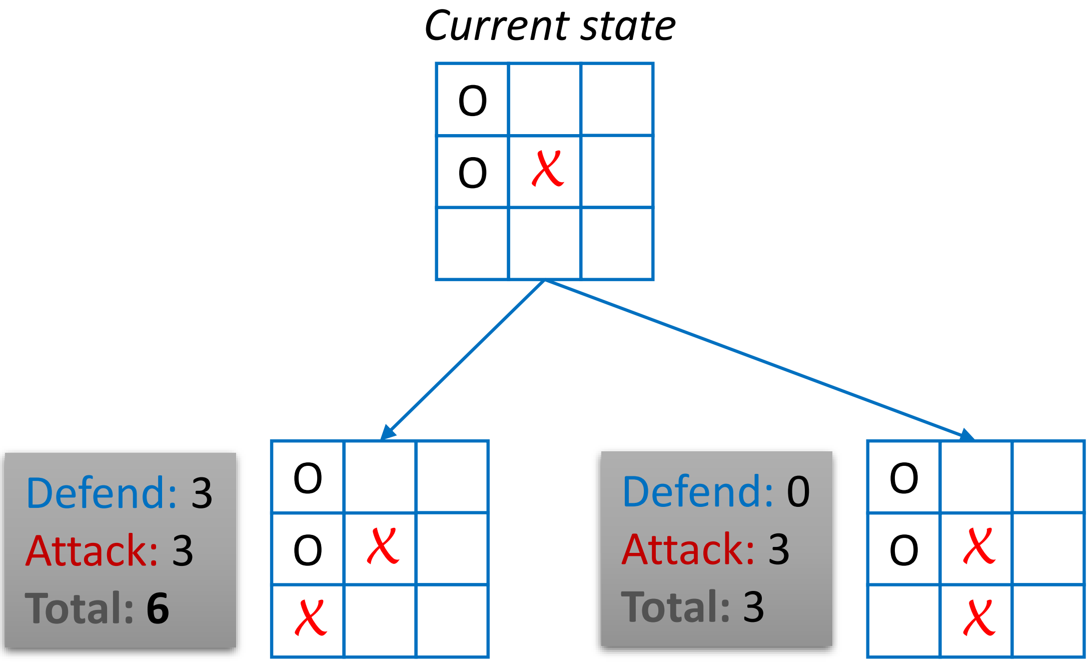
```
# The rest…
best_move = None
crr_benefit = 1000#if deepth is odd, 0 if not
for move in can_move(crr_state, turn):
    get_benefit = mini_max(move, deepth - 1,
                           change_turn, crr_benefit)
    if can_pruning(turn, tgt_benefit, get_benefit):
       return None, None

    if get_benefit > crr_benefit and deepth%2==1 or
       get_benefit < crr_benefit and deepth%2==0:
       crr_benefit = get_benefit[1]
       best_move = move

return best_move, crr_benefit
```

Profit/Benefit Function

The benefit of a state depends on two main part:

- How many point can earn from defend move.
- How many point can earn from attack move.

* *Do not do stupid move.*



Current state

O		
O	X	

Defend: 3
Attack: 3
Total: **6**

O		
O	X	
X		

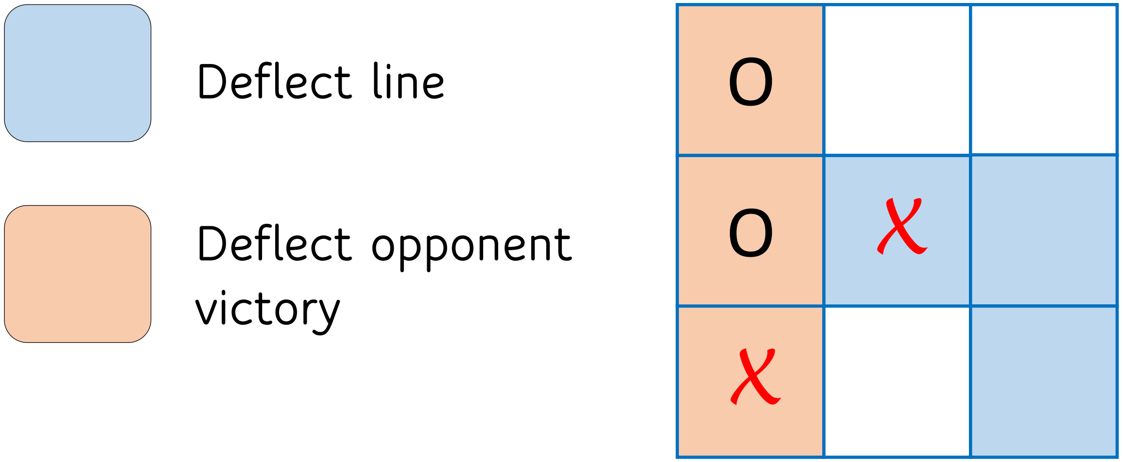
Defend: 0
Attack: 3
Total: 3

O		
O	X	
	X	

Profit/Benefit Function

Point of defend move in gomoku/tic-tac-toe game consist of:

- How many lines you can deflect, prioritize the longest line first.
- Move into the position that our opponent can get the victory.



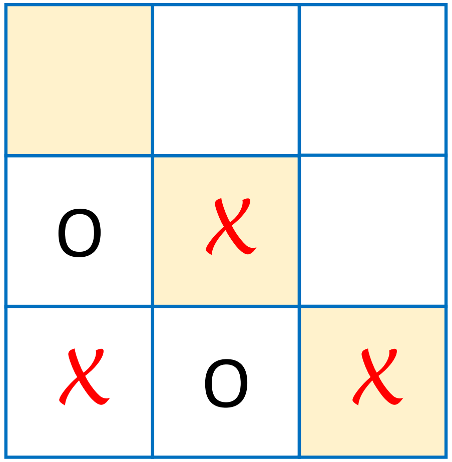
O		
O	X	
X		

Profit/Benefit Function

Point of attack move in caro/gomoku game consist of:

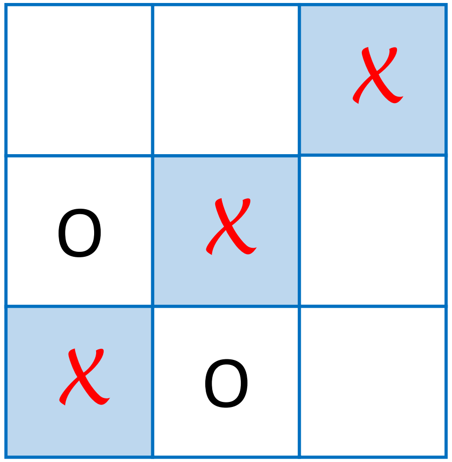
- How many lines you can make, prioritize the longest line first.
- Move into the position that we can get the victory.

Make a line



O	X	
X	O	X

Get the victory



		X
O	X	
X	O	

Profit/Benefit Function

Stupid move is:

- Move to the position can't get the victory after that. (1)
- Move into the position not necessary to defend. (2)

(1)

O	X	X
	O	

(2)

O		
X	O	X

Profit/Benefit Function

Pseudocode

```
def get_max_benefit(crr_state, tgt_benefit):
    best_move = None
    crr_benefit = 0
    for move in can_move(crr_state, turn):
        if not is_stupid_move(move):
           get_benefit = depend(move) + attack(move)

           if can_pruning('bot', tgt_benefit,
                                       get_benefit):
              return None, None

           if get_benefit > crr_benefit:
              crr_benefit = get_benefit
              best_move = move

    return best_move, crr_benefit
```