

FAI LAB 5

Adversarial search

Paolo Morettin

2024-25

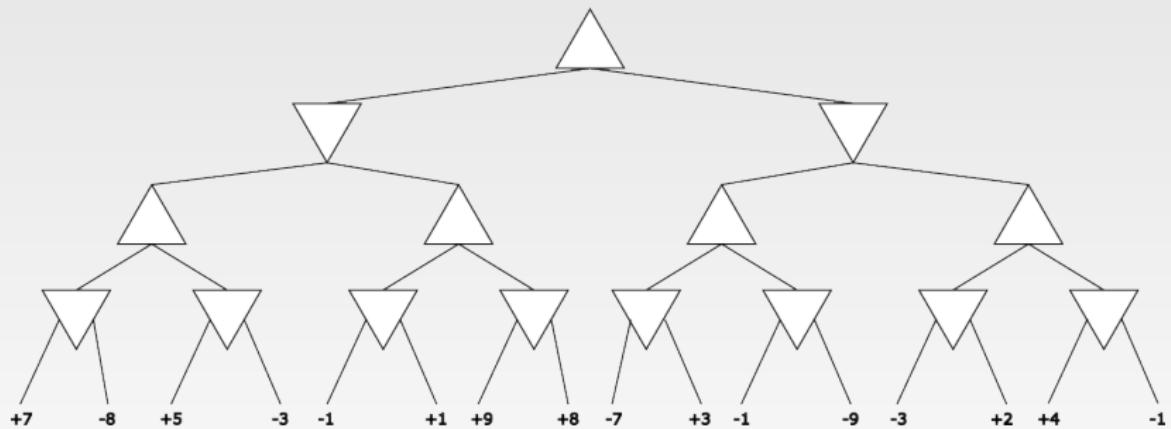
Minimax

```
function MINIMAX-SEARCH(game, state) returns an action
    player  $\leftarrow$  game.TO-MOVE(state)
    value, move  $\leftarrow$  MAX-VALUE(game, state)
    return move

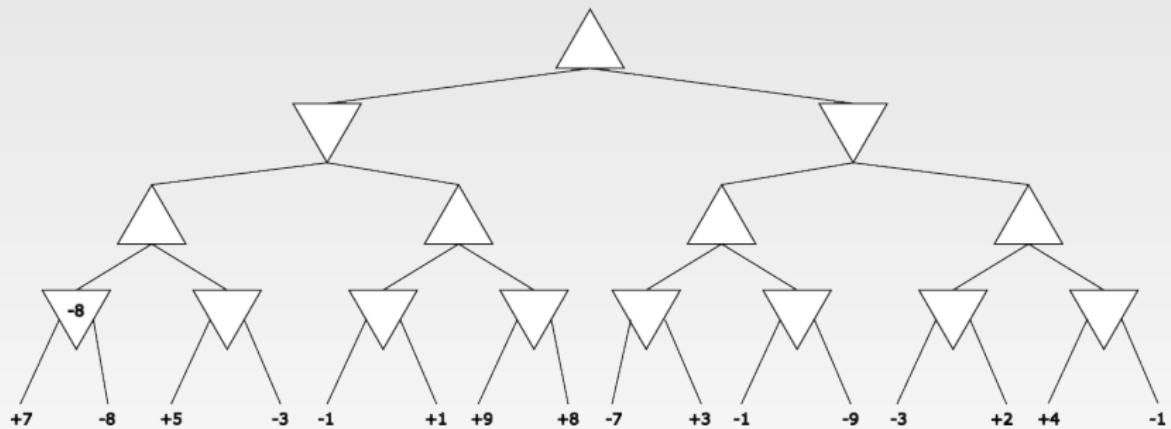
function MAX-VALUE(game, state) returns a (utility, move) pair
    if game.IS-TERMINAL(state) then return game.UTILITY(state, player), null
    v  $\leftarrow$   $-\infty$ 
    for each a in game.ACTIONS(state) do
        v2, a2  $\leftarrow$  MIN-VALUE(game, game.RESULT(state, a))
        if v2 > v then
            v, move  $\leftarrow$  v2, a
    return v, move

function MIN-VALUE(game, state) returns a (utility, move) pair
    if game.IS-TERMINAL(state) then return game.UTILITY(state, player), null
    v  $\leftarrow$   $+\infty$ 
    for each a in game.ACTIONS(state) do
        v2, a2  $\leftarrow$  MAX-VALUE(game, game.RESULT(state, a))
        if v2 < v then
            v, move  $\leftarrow$  v2, a
    return v, move
```

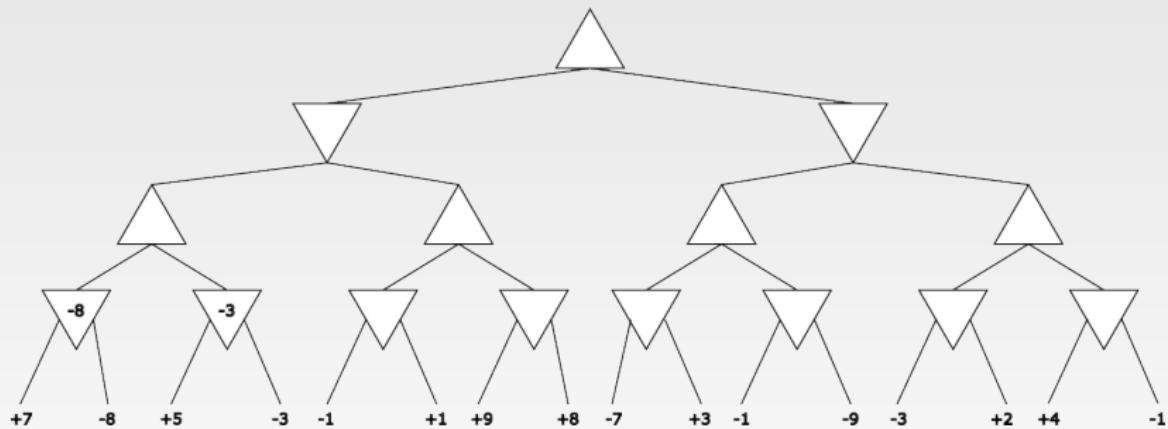
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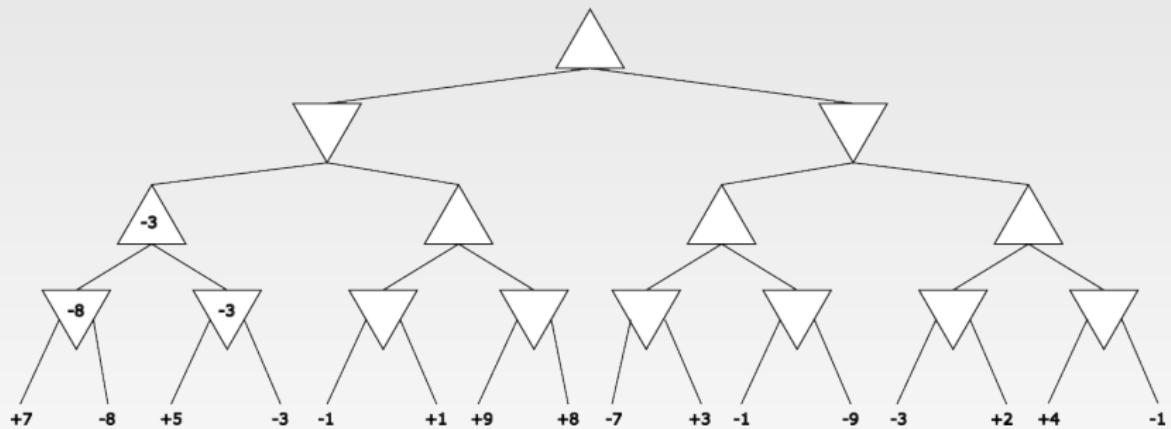
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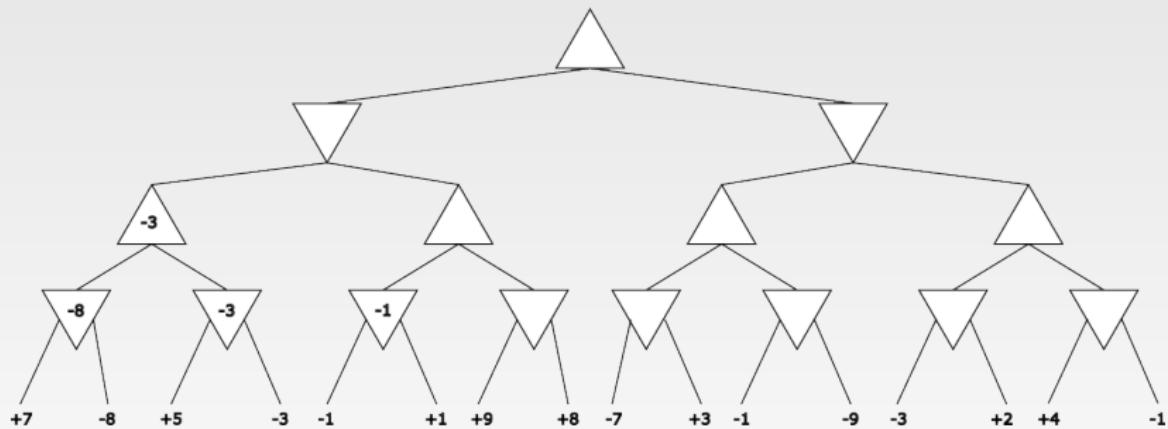
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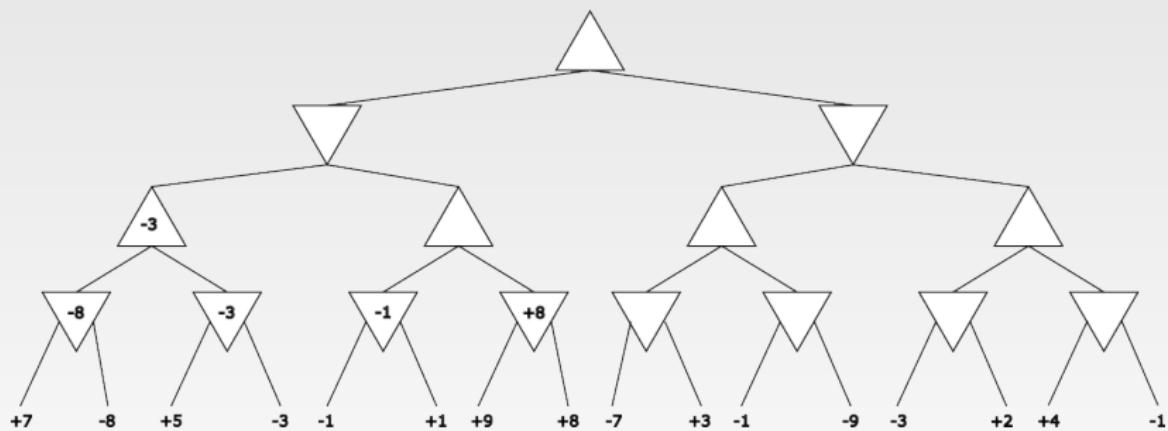
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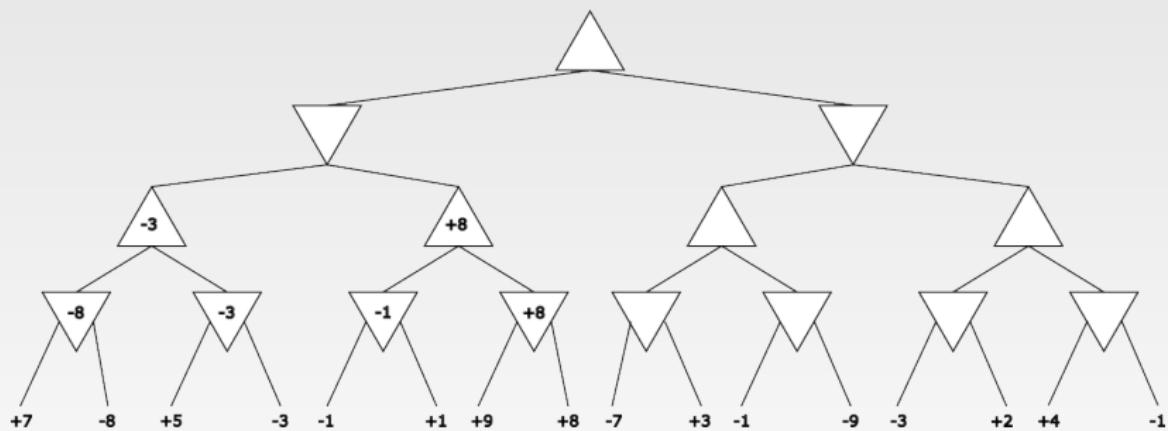
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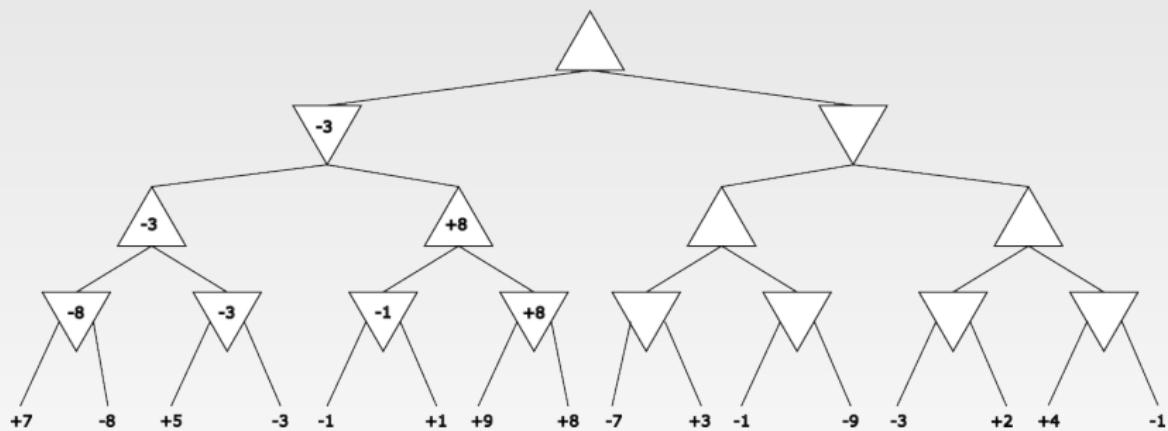
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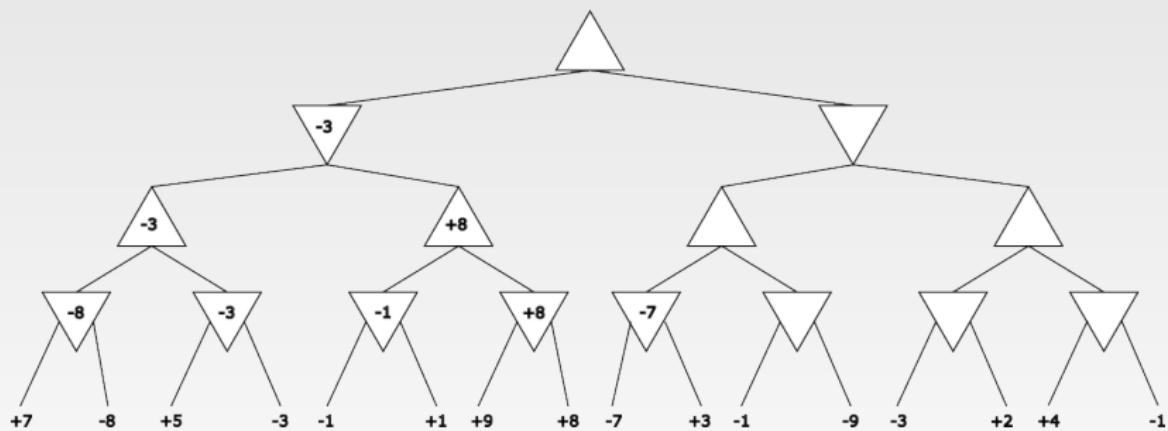
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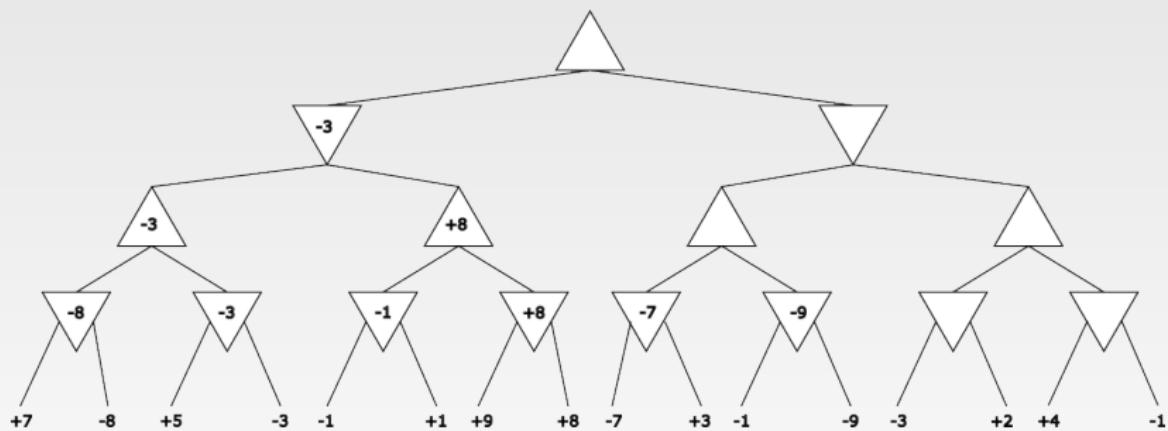
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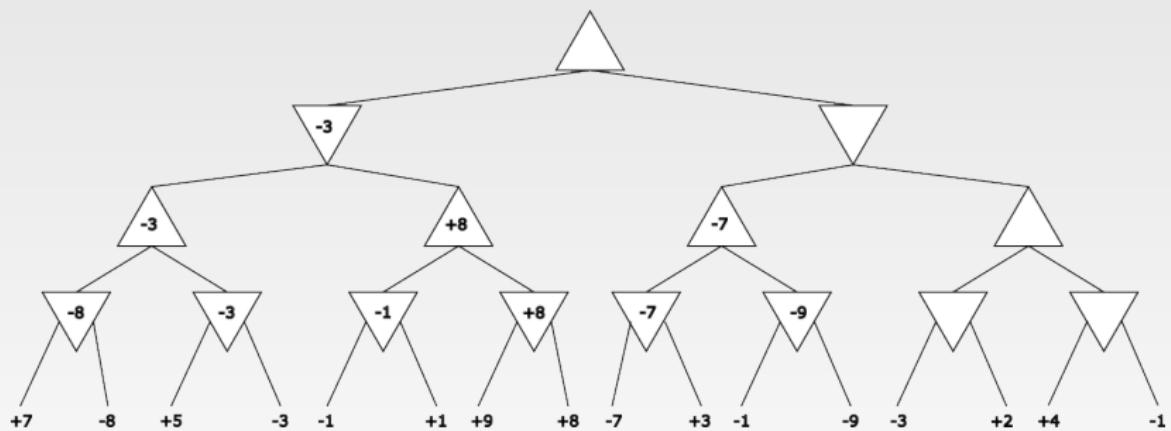
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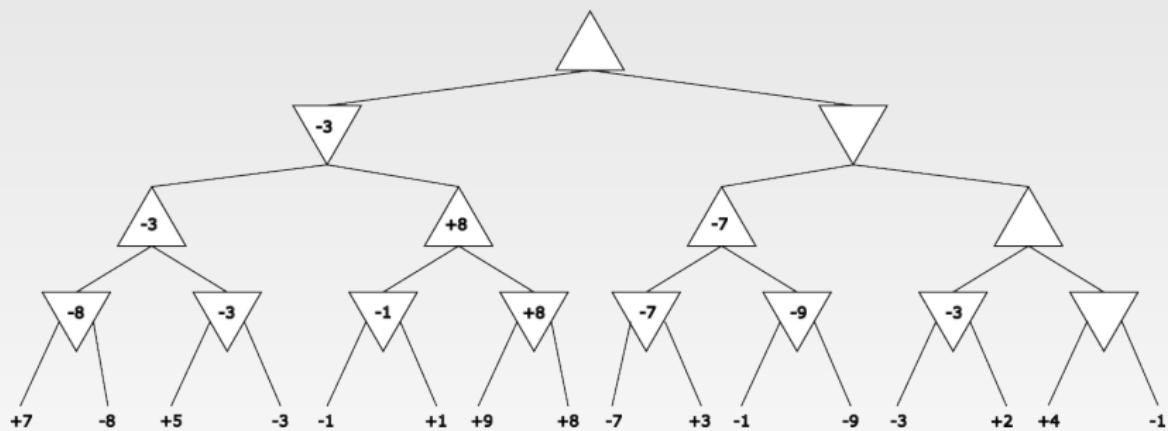
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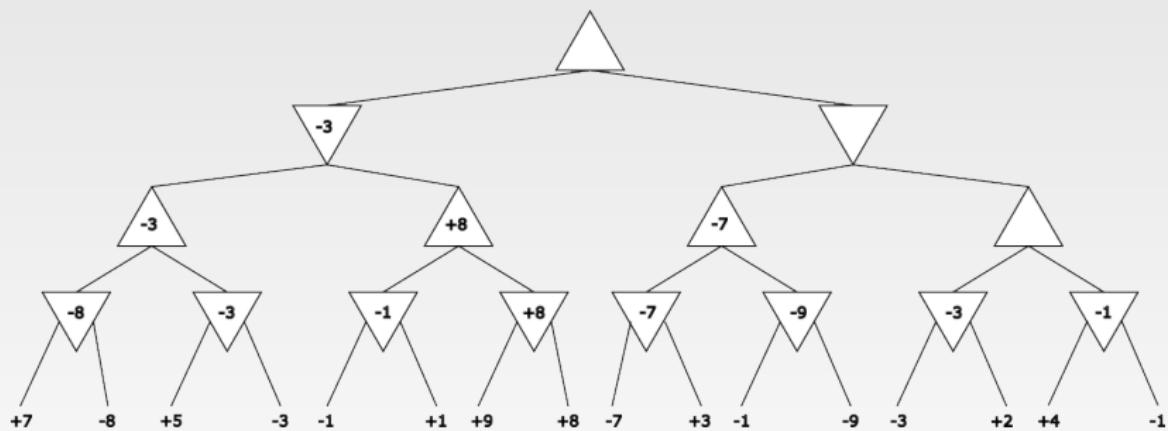
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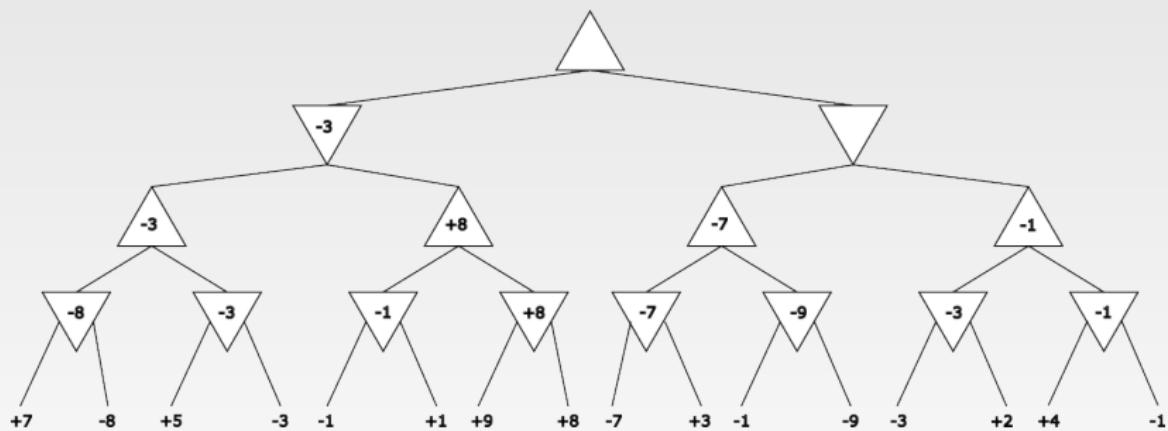
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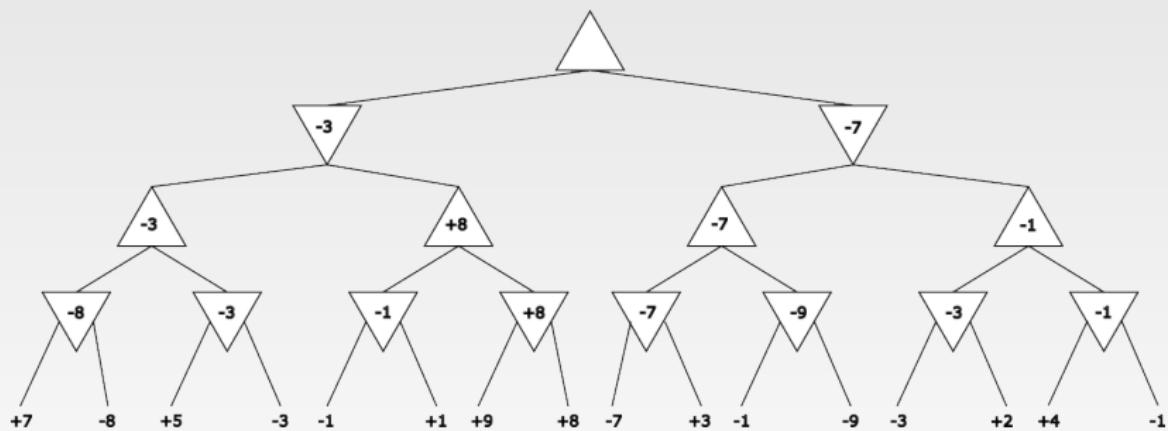
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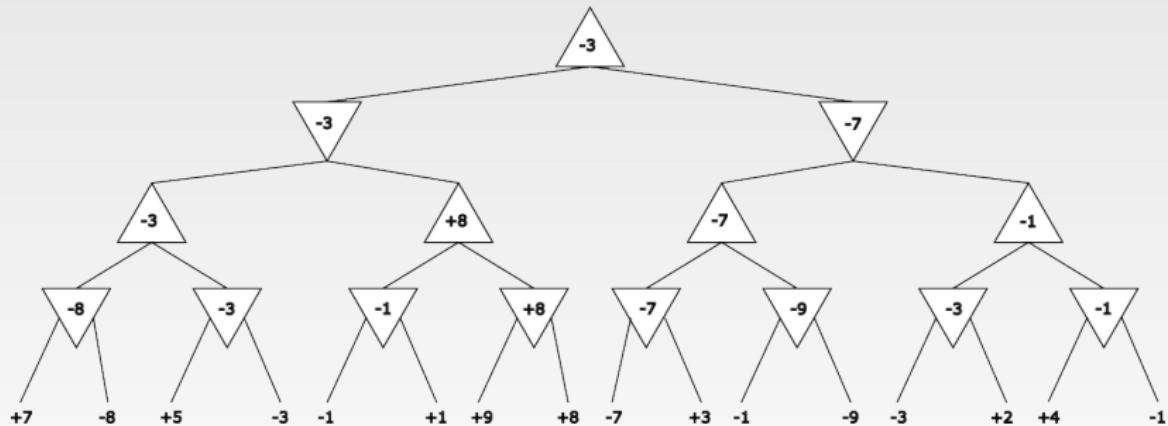
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Minimax



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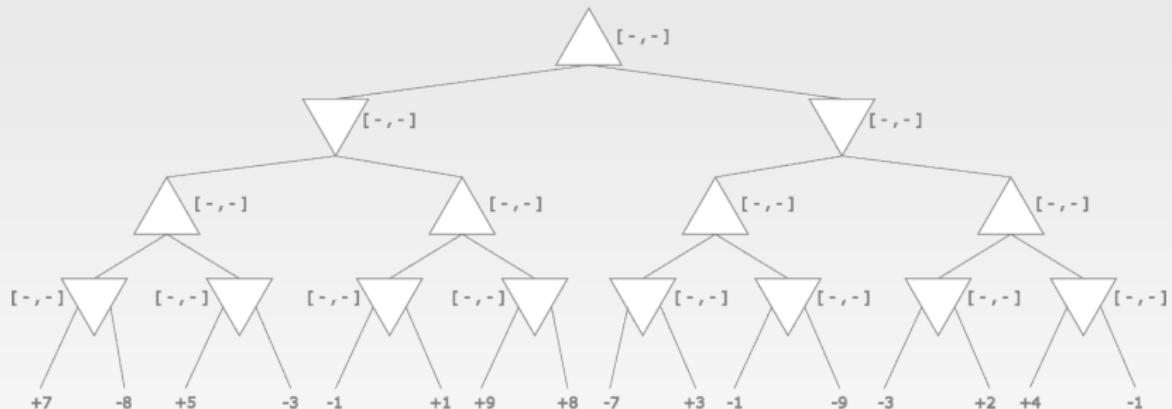
$\alpha - \beta$ pruning

```
function ALPHA-BETA-SEARCH(game, state) returns an action
    player  $\leftarrow$  game.TO-MOVE(state)
    value, move  $\leftarrow$  MAX-VALUE(game, state,  $-\infty$ ,  $+\infty$ )
    return move

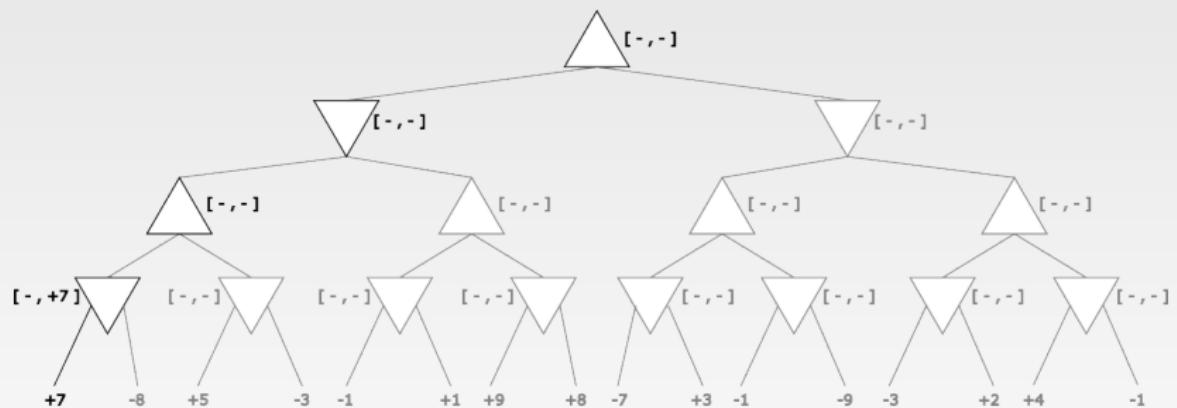
function MAX-VALUE(game, state,  $\alpha$ ,  $\beta$ ) returns a (utility, move) pair
    if game.IS-TERMINAL(state) then return game.UTILITY(state, player), null
    v  $\leftarrow$   $-\infty$ 
    for each a in game.ACTIONS(state) do
        v2, a2  $\leftarrow$  MIN-VALUE(game, game.RESULT(state, a),  $\alpha$ ,  $\beta$ )
        if v2  $>$  v then
            v, move  $\leftarrow$  v2, a
             $\alpha \leftarrow \text{MAX}(\alpha, v)$ 
        if v  $\geq \beta$  then return v, move
    return v, move

function MIN-VALUE(game, state,  $\alpha$ ,  $\beta$ ) returns a (utility, move) pair
    if game.IS-TERMINAL(state) then return game.UTILITY(state, player), null
    v  $\leftarrow$   $+\infty$ 
    for each a in game.ACTIONS(state) do
        v2, a2  $\leftarrow$  MAX-VALUE(game, game.RESULT(state, a),  $\alpha$ ,  $\beta$ )
        if v2  $<$  v then
            v, move  $\leftarrow$  v2, a
             $\beta \leftarrow \text{MIN}(\beta, v)$ 
        if v  $\leq \alpha$  then return v, move
    return v, move
```

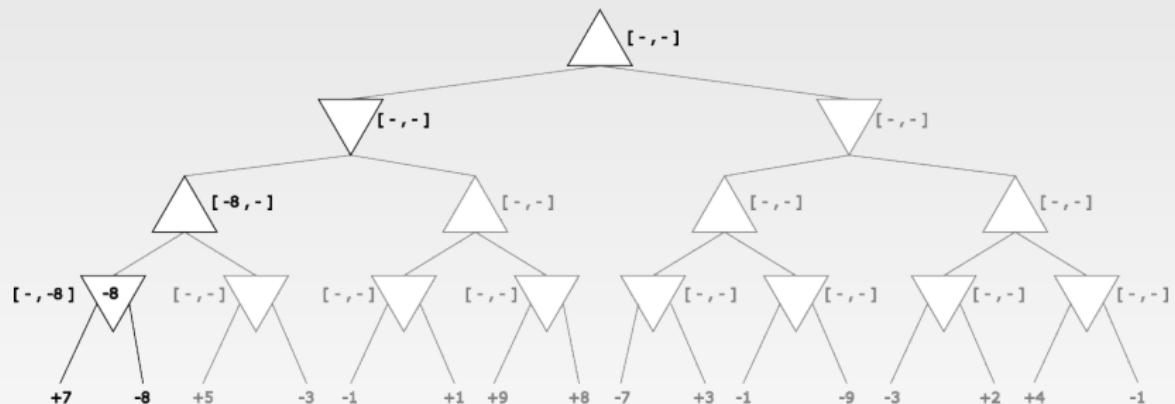
$\alpha - \beta$ pruning



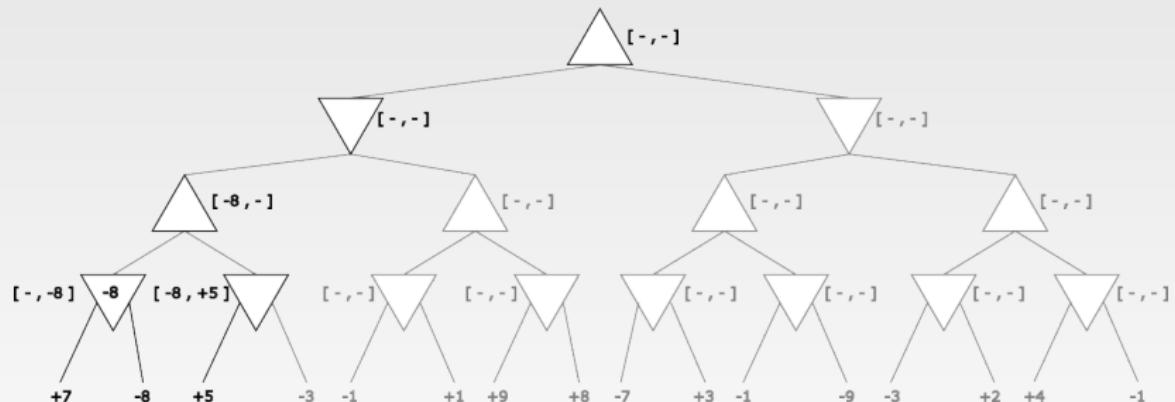
$\alpha - \beta$ pruning



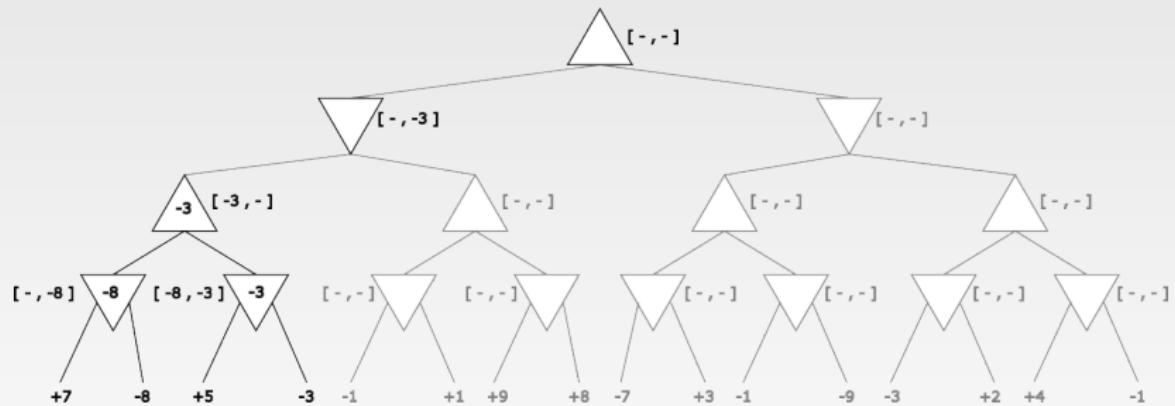
$\alpha - \beta$ pruning



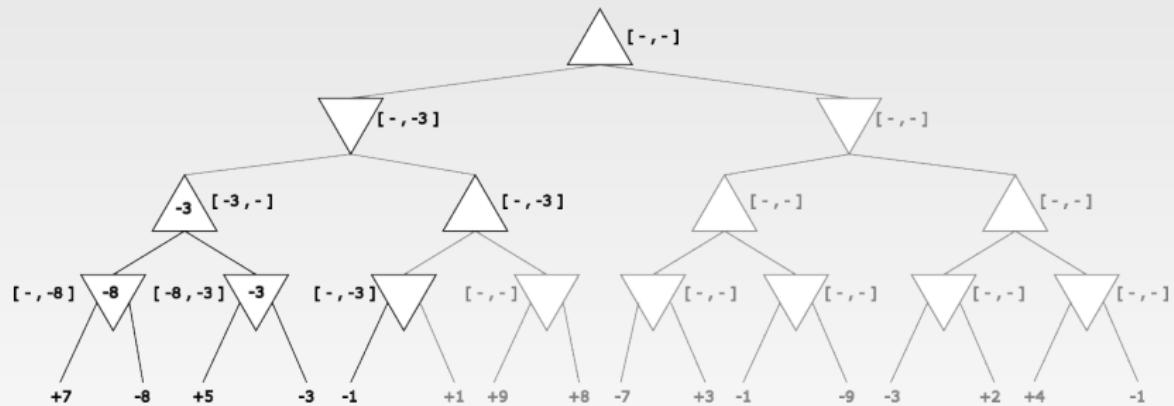
$\alpha - \beta$ pruning



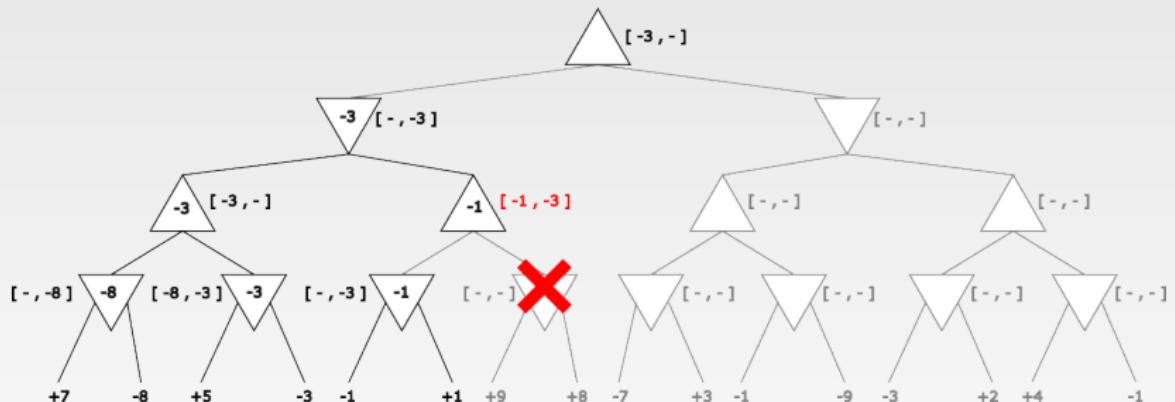
$\alpha - \beta$ pruning



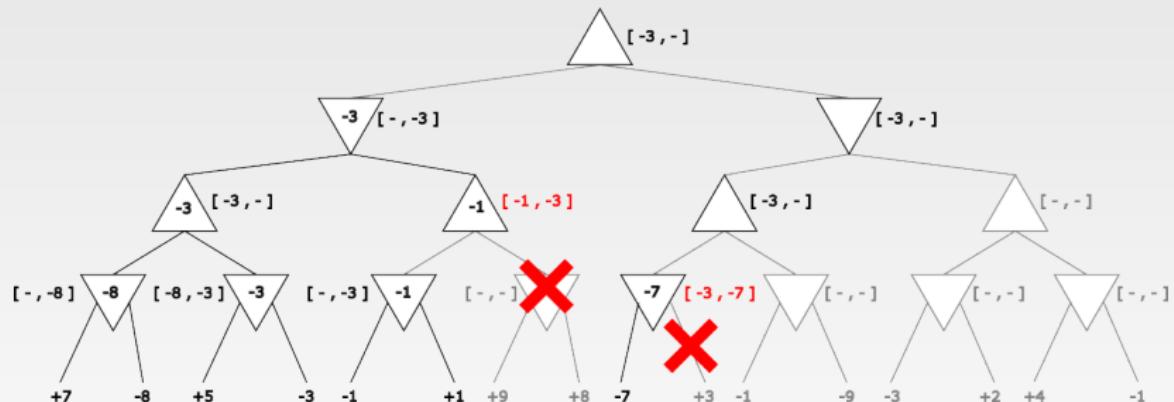
$\alpha - \beta$ pruning



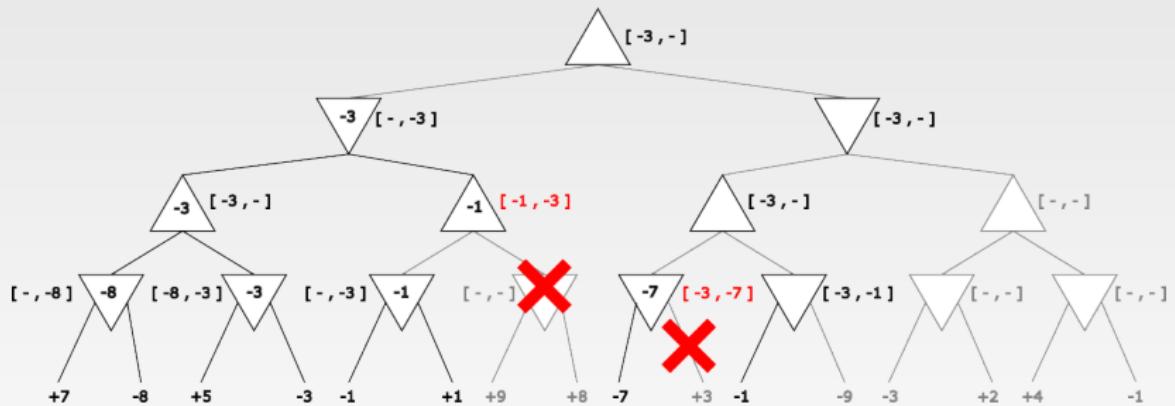
$\alpha - \beta$ pruning



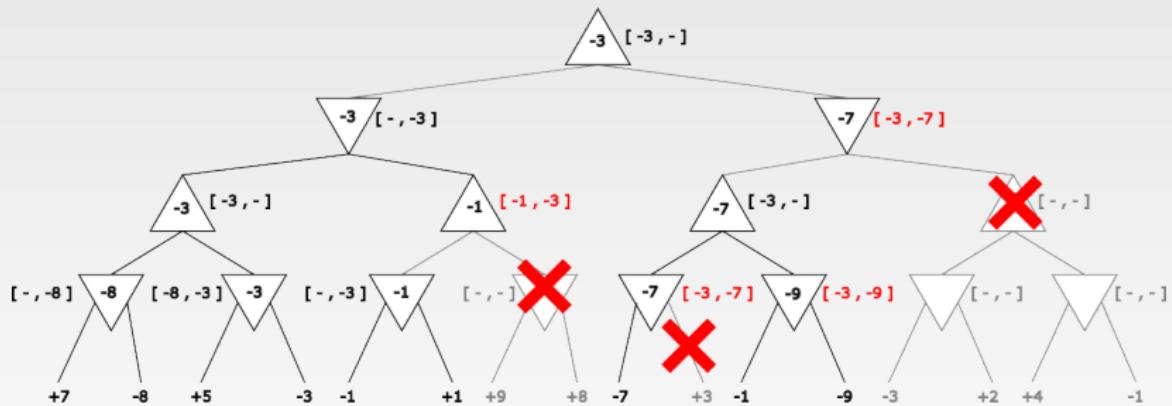
$\alpha - \beta$ pruning



$\alpha - \beta$ pruning



$\alpha - \beta$ pruning



Simple dice game

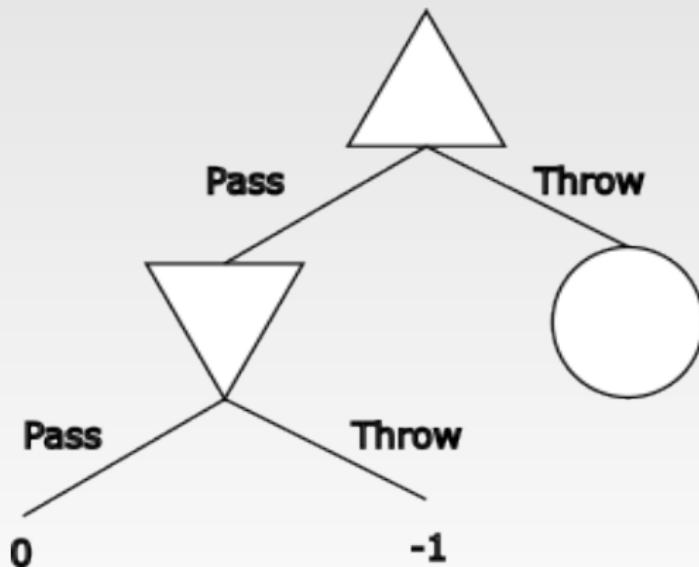
- both *MAX* and *MIN* players have 2 moves:
 - *throw* an even d6 dice
 - *pass*
- the game is draw (0) if both passed or the two throws are the same
- otherwise the player with highest throw wins (either +1 or -1)
- **MAX goes first**

Simple dice game

Should *MAX* pass?

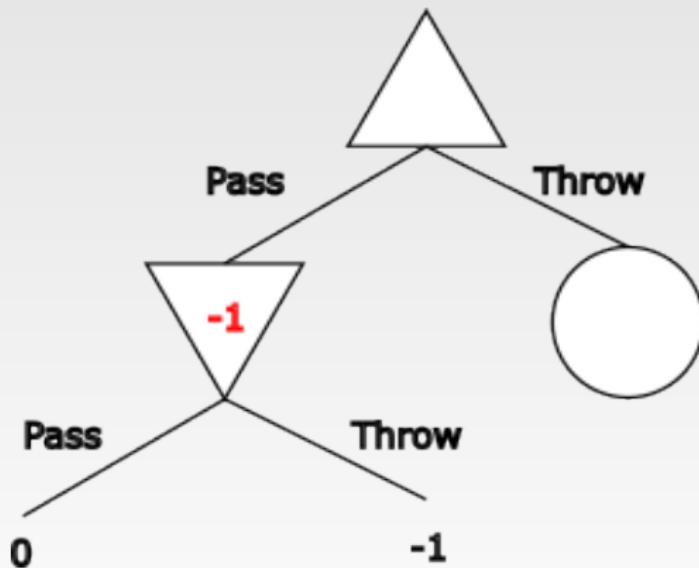
Simple dice game

Should MAX pass?



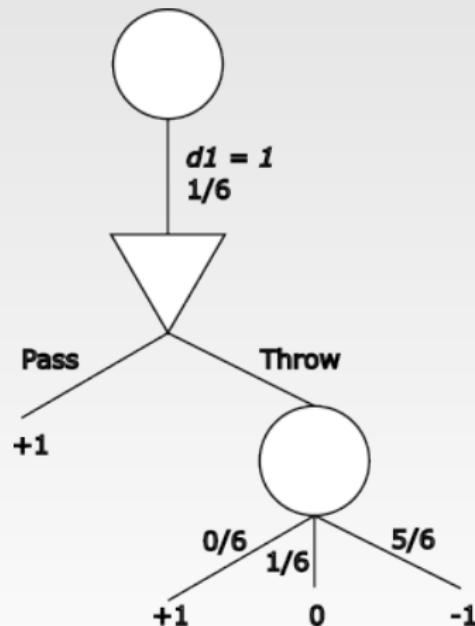
Simple dice game

Should MAX pass?



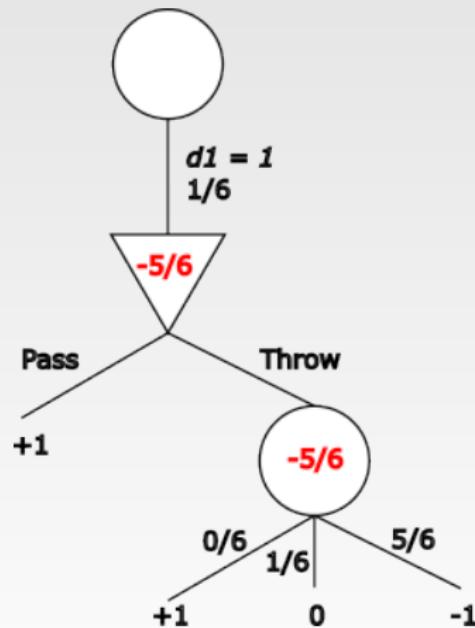
Simple dice game

Should MAX throw the d6?



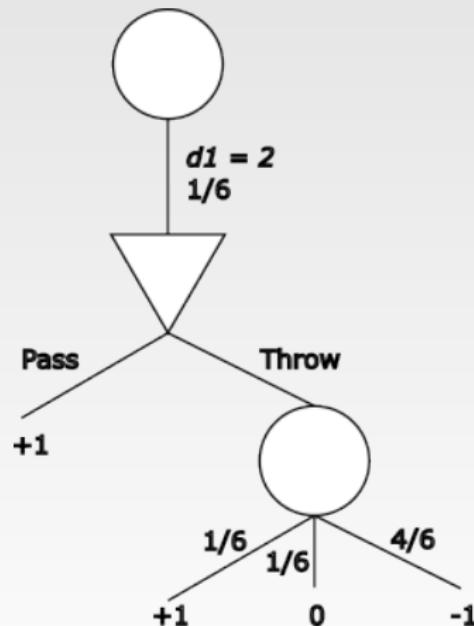
Simple dice game

Should MAX throw the d6?



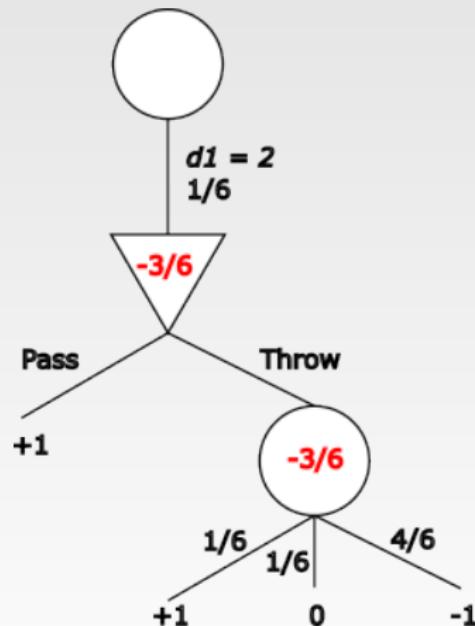
Simple dice game

Should MAX throw the d6?



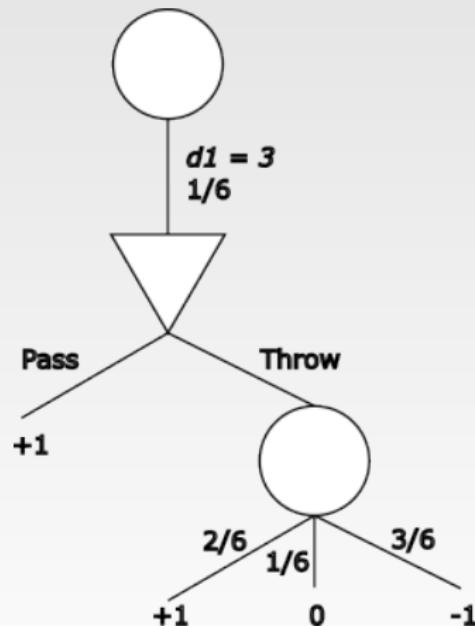
Simple dice game

Should MAX throw the d6?



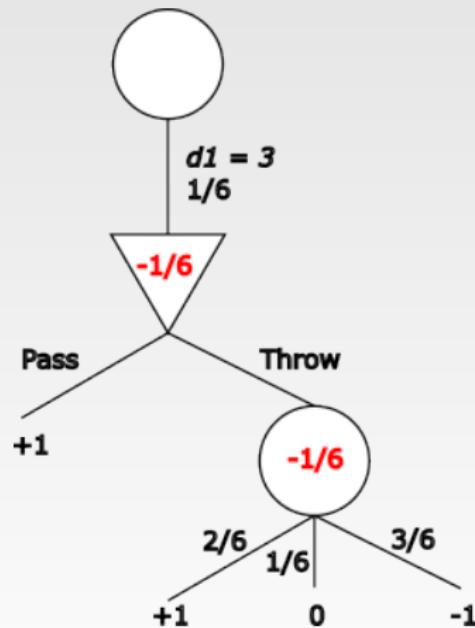
Simple dice game

Should MAX throw the d6?



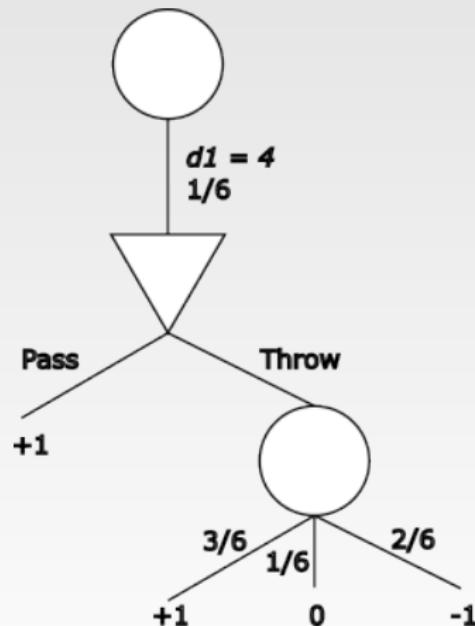
Simple dice game

Should MAX throw the d6?



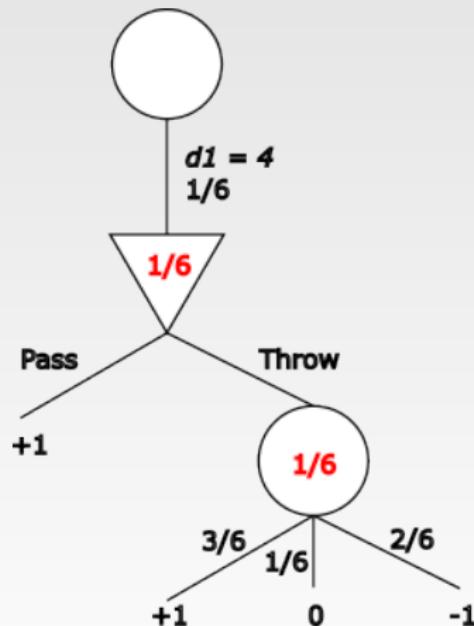
Simple dice game

Should MAX throw the d6?



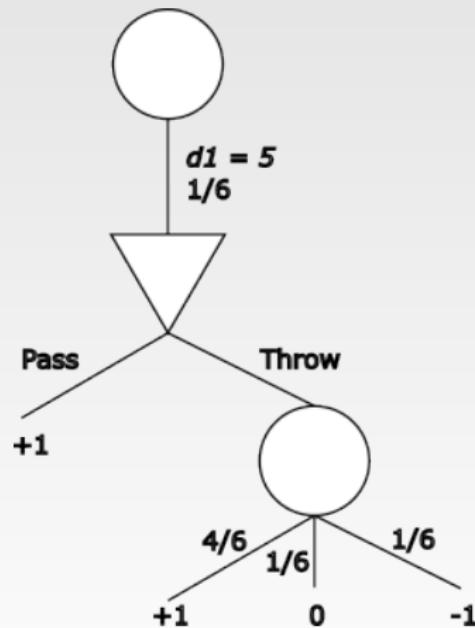
Simple dice game

Should MAX throw the d6?



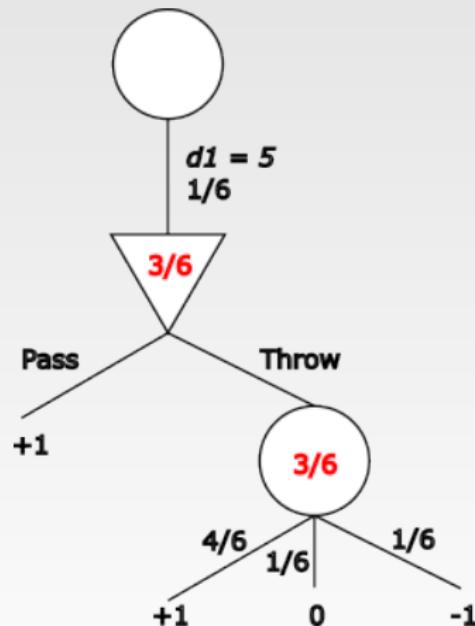
Simple dice game

Should MAX throw the d6?



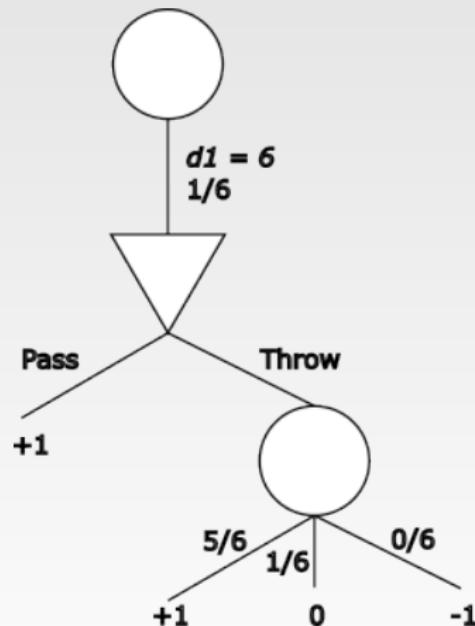
Simple dice game

Should MAX throw the d6?



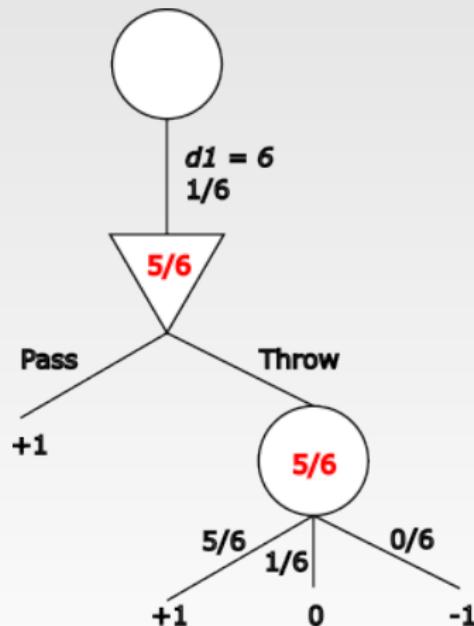
Simple dice game

Should MAX throw the d6?



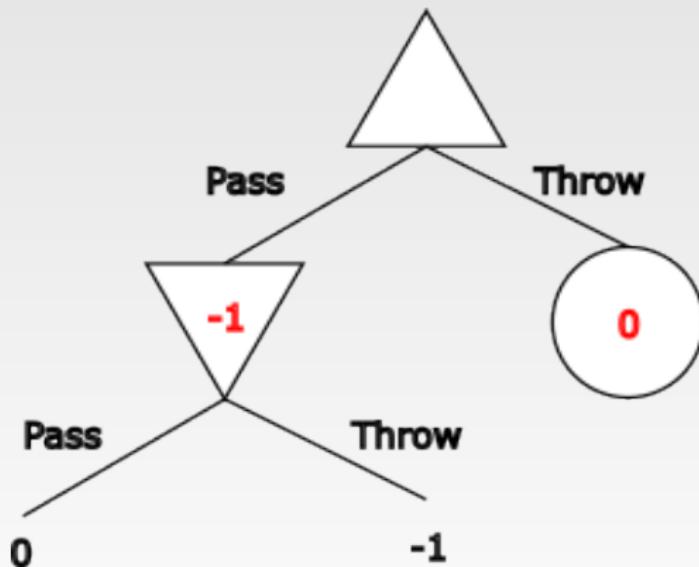
Simple dice game 1.0

Should MAX throw the d6?



Simple dice game 1.0

Should MAX throw the d6? Always!



Briscola

