- **MinMax Algorithm**

Machine Learning

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MINI-MAX ALGORITHM

- Mini-max algorithm is a recursive or backtracking algorithm which is used in decision-making and game theory.
- It provides an optimal move for the player assuming that opponent is also playing optimally.
- Mini-Max algorithm uses recursion to search through the game-tree.
- Min-Max algorithm is mostly used for game playing in AI. Such as Chess, Checkers, tic-tac-toe, go, and various tow-players game.
- This Algorithm computes the minimax decision for the current state.

MINI-MAX ALGORITHM

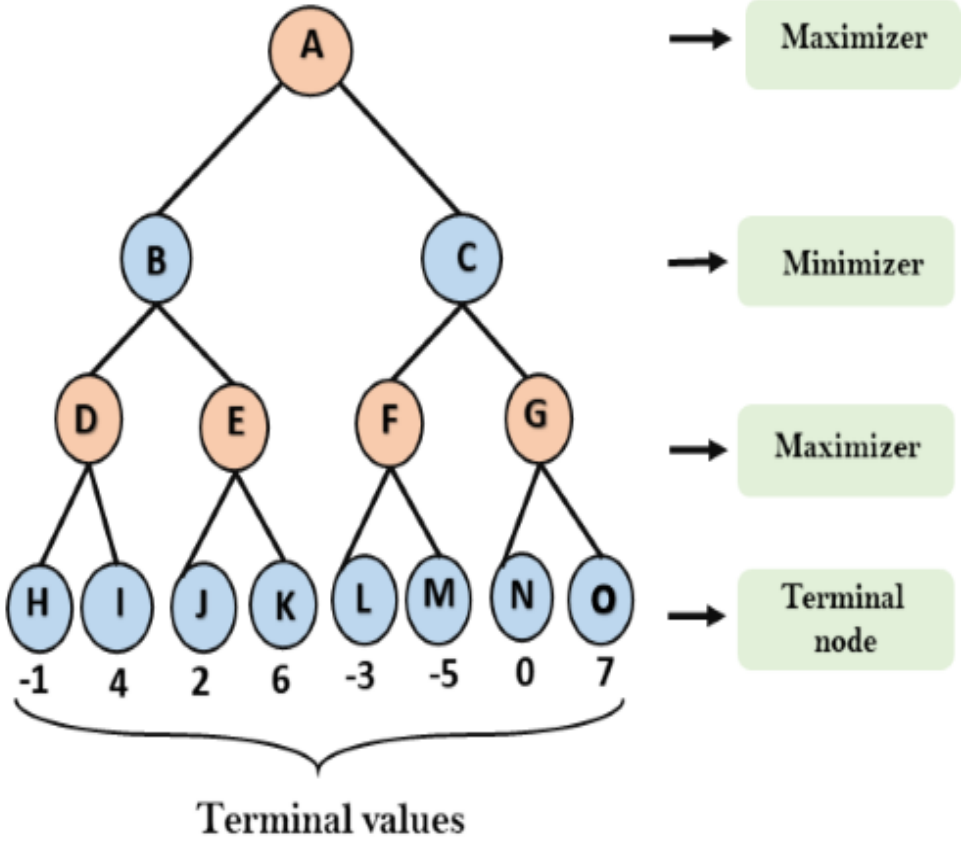
- In this algorithm two players play the game, one is called MAX and other is called MIN.
- Both the players fight it as the opponent player gets the minimum benefit while they get the maximum benefit.
- Both Players of the game are opponent of each other, where MAX will select the maximized value and MIN will select the minimized value.

MINI-MAX ALGORITHM

- The minimax algorithm performs a depth-first search algorithm for the exploration of the complete game tree.
- The minimax algorithm proceeds all the way down to the terminal node of the tree, then backtrack the tree as the recursion.

WORKING OF MIN-MAX ALGORITHM

- The working of the minimax algorithm can be easily described using an example. Below we have taken an example of game-tree which is representing the two-player game.
- In this example, there are two players one is called Maximizer and other is called Minimizer.
- Maximizer will try to get the Maximum possible score, and Minimizer will try to get the minimum possible score.



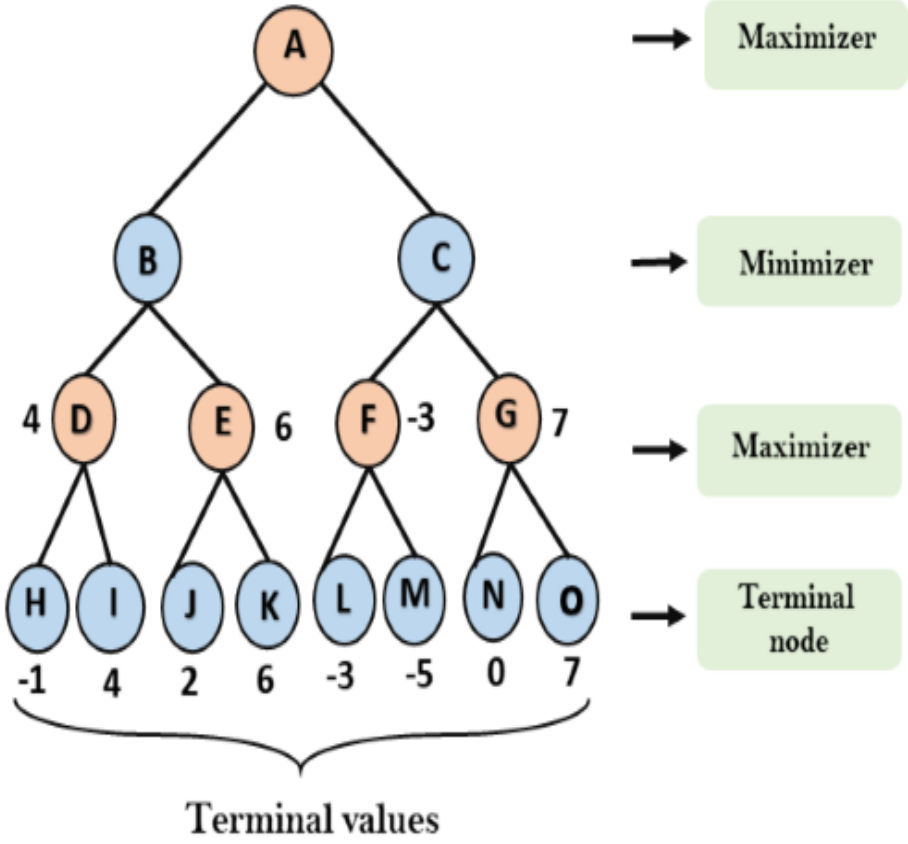
WORKING OF MIN-MAX ALGORITHM

Following are the main steps involved in solving the two-player game tree:

- **Step-1:** In the first step, the algorithm generates the entire game-tree and apply the utility function to get the utility values for the terminal states.
- In the below tree diagram, let's take A is the initial state of the tree.
- Suppose maximizer takes first turn which has worst-case initial value =- infinity, and minimizer will take next turn which has worst-case initial value = +infinity.

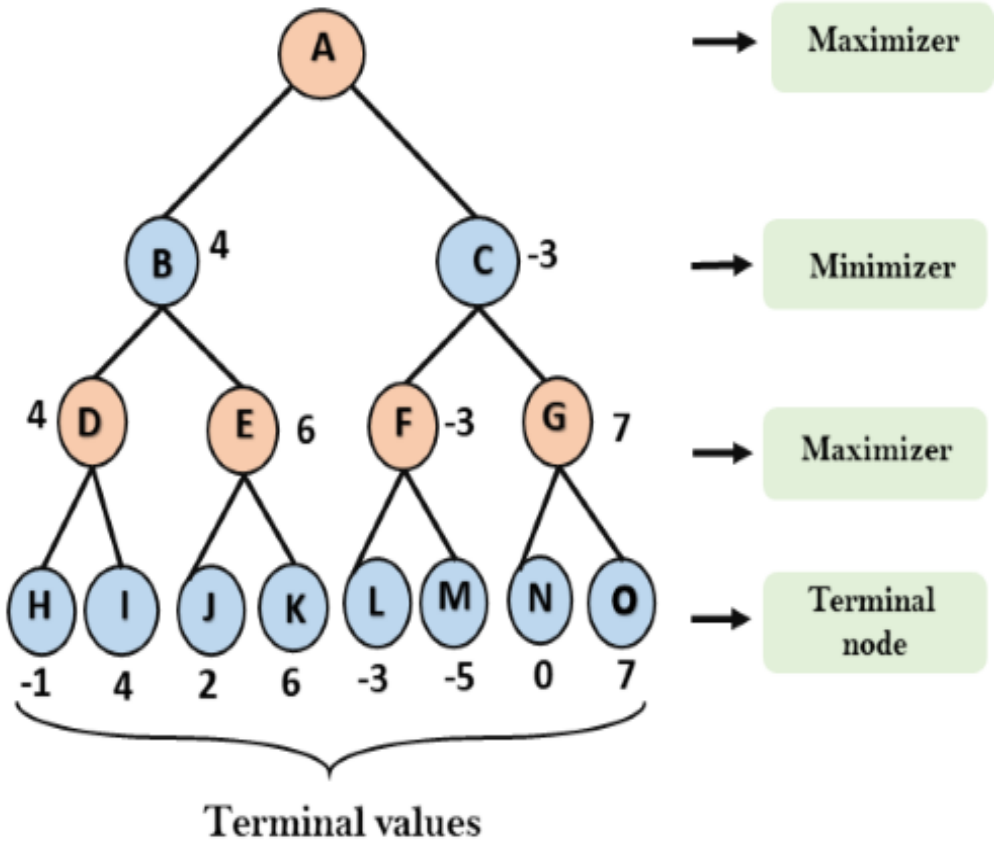
WORKING OF MIN-MAX ALGORITHM

- **Step 2:** Now, first we find the utilities value for the Maximizer, its initial value is -∞, so we will compare each value in terminal state with initial value of Maximizer and determines the higher nodes values. It will find the maximum among the all.
  - For node D max(-1,- -∞) => max(-1,4)= 4
  - For Node E max(2, -∞) => max(2, 6)= 6
  - For Node F max(-3, -∞) => max(-3,-5) = -3
  - For node G max(0, -∞) = max(0, 7) = 7



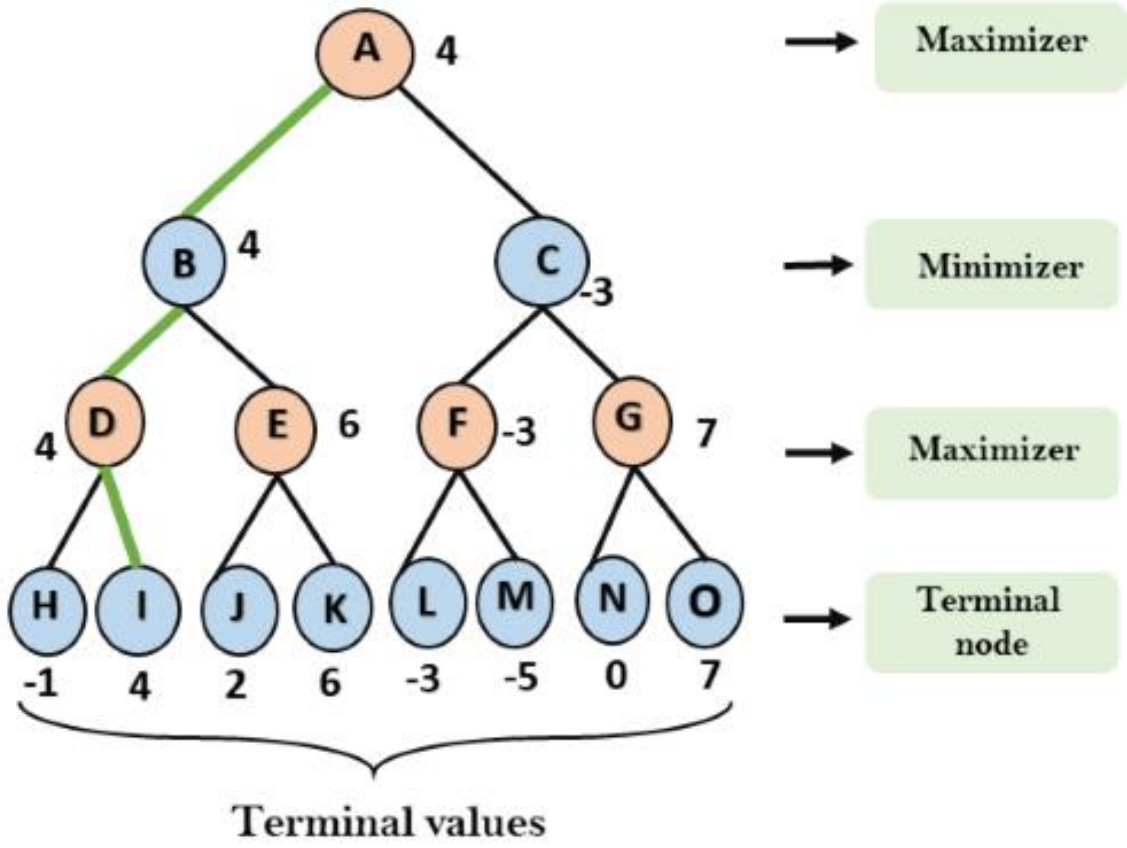
WORKING OF MIN-MAX ALGORITHM

- **Step 3:** In the next step, it's a turn for minimizer, so it will compare all nodes value with +∞, and will find the 3rd layer node values.
  - For node B= min(4,6) = 4
  - For node C= min (-3, 7) = -3



WORKING OF MIN-MAX ALGORITHM

- **Step 4:** Now it's a turn for Maximizer, and it will again choose the maximum of all nodes value and find the maximum value for the root node.
- In this game tree, there are only 4 layers, hence we reach immediately to the root node, but in real games, there will be more than 4 layers.
  - For node A max(4, -3)= 4



LIMITATION OF THE MINIMAX ALGORITHM

- The main drawback of the minimax algorithm is that it gets really slow for complex games such as Chess, go, etc.
- This type of games has a huge branching factor, and the player has lots of choices to decide
- This limitation of the minimax algorithm can be improved from **alpha-beta pruning** which we have discussed in the next topic.

THANK YOU