Block Slide Puzzle (2048) Using Min-max Algorithm

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PROBLEM STATEMENT:

A strategy to be employed in every game playing algorithm. With the min-max algorithm, the strategy assumes that the computer opponent is perfect in minimizing player's outcome. This is done irrespective of whether or not the opponent is perfect in doing so.

It is to formulate for two-player game theory, covering both the cases where players take alternate moves and those where they make simultaneous moves, it has also been extended to more complex games and to general decision-making in the presence of uncertainty.

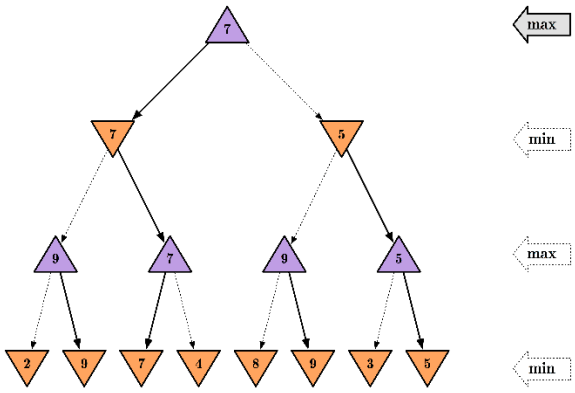
To check whether or not the current move is better than the best move we take the help of min-max function which will consider all the possible ways the game can go and returns the best value for that move, assuming the opponent also plays optimally

OBJECTIVE:

To design and implement an algorithm for determining the best possible move for a puzzle game (2048) as the rules of most puzzle games can have far-reaching positive effects when they are applied to real-life situations.

ALGORITHM DESCRIPTION:

Min-max is a kind of backtracking algorithm that is used in decision making and game theory to find the optimal move for a player, assuming that your opponent also plays optimally. It is widely used in two player turn-based games such as Tic-Tac-Toe, Backgammon, Manacle, Chess, etc.



This algorithm assumes that there are two players. One is named the Min and the other one is the Max. Both the players alternate in turns. The Max moves first. The aim of max is to maximize a heuristic score and that of min is to minimize the same. For every player, a min-max value is computed. This value is the best achievable payoff against his play. The move with the optimum min-max value is chosen by the player.

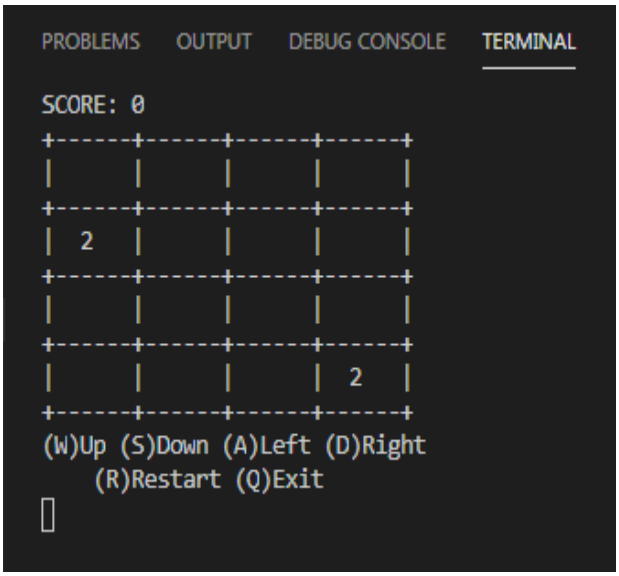
Usually, the number of nodes to be explored by this algorithm is huge. In order to optimize it, pruning is used.

Here, the 4x4 grid with a randomly placed 2/4 tile is the initial scenario. The computer player (MAX) makes the first move. This move is chosen by the min-max algorithm. After his play, the opponent randomly generates a 2/4 tile. The entire process continues until the game is over.

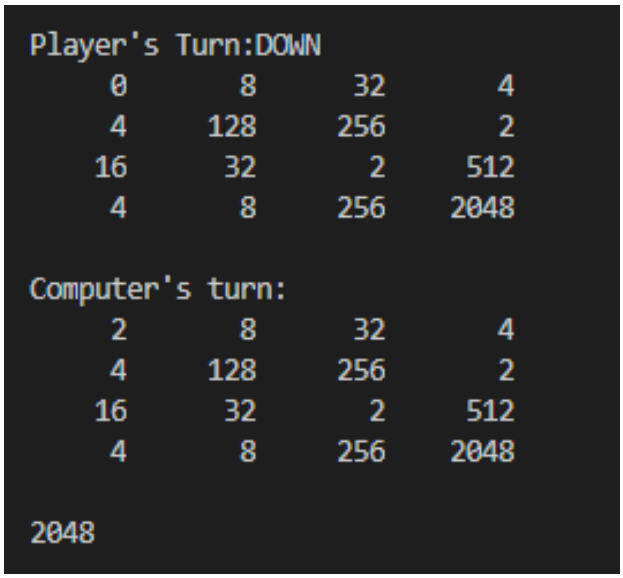
While using the min-max algorithm, the MAX uses his move (UP, DOWN, RIGHT and LEFT) for finding the possible children nodes. Whereas the MIN will have the 2/4 tiles placed in all the empty cells for finding its children. Hence, for every max, there will be at most 4 children corresponding to each and every direction. And for MIN, the number of children will be 2*n where n is the number of empty cells in the grid.

RESULT:

1. MANUAL MODE



2. AUTO MODE (i.e. computer)



TIME COMPLEXITY:

Min-max is an algorithm that searches game trees. It assumes that the players take alternate moves. It uses a utility function whose values are good for player 1 when they are big and whose values are good for player 2 when the values are small. Thus, the first player's (MAX's) goal is to select a move that maximizes the utility function. The second player's (MIN's) goal is to select a move that minimizes the utility function (hence the name of the algorithm). It maximizes the utility under the assumption that the opponent will play perfectly.

The time complexity of min-max is O(b^m) and the space complexity is O(bm), where b is the number of legal moves at each point and m is the maximum depth of the tree.

REFERENCES:

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https://sandipanweb.wordpress.com/2017/03/06/using-minimax-with-alpha-beta-pruning-and-heuristic-evaluation-to-solve-2048-game-with-computer/

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ACTUAL GAME:

http://2048game.com/