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Advance Chess Engine based on min-max Algorithm

Manavkumar Patel[1], Kailas Salunkhe[2], Abhishek Khedekar[3]

U.G. Student, Department of Computer Engineering, RMDSSOE Engineering College, Warje, Pune, India[1]

U.G. Student, Department of Computer Engineering, VIIT College, Laxmi Nagar, Kondhwa, Pune India[2]

U.G. Student, Department of Computer Engineering, VIIT College, Laxmi Nagar, Kondhwa, Pune India[3]

ABSTRACT:The process of playing games is a key area for heuristic search, and it is illustrated by a unique and/or tree. When searching the game-playing tree for solutions, minimax is always used. This study proposes a plan based on minimax pruning where child nodes are put into the game-playing tree from large value of estimate function to small one when the node of no receiving fixed ply depth is expanded. It enhances search results. A key field of research in computer systems is optimization, or finding the optimum course of action given different conditions, such as the environment's state or the system's objective.
Any search algorithm can result in the development of the entire state search space, or minimax algorithm, by seeking the best feasible solution from the set of all known possibilities.

KEYWORDS:Stockfish, Minimax, Portable Game Notation (PGN), python-chess, Python, Scalable Vector Graphics.

I. INTRODUCTION

Computer games are now a popular form of entertainment. For instance, one in two kids play video games, and in the US, game sales outpace book sales. Additionally, the global market for video games is expanding considerably more quickly than the box office for movies, DVD rentals, and even the sale of music. Unfortunately, the majority of current video games are quite stressful and uninformed. This reality leads parents to prevent a significant number of kids from playing computer games. In light of the aforementioned, proposed model is an engine for the creation of Chess, a globally playable multiplayer intelligent board game.

This model, has been trained to play the game of chess. There are several chess engines available nowadays, like stockfish 13, alpha-zero, and many more. These engines are taught using increasingly complicated algorithms, making them challenging for beginners to grasp. As a result, a practical and simple model is suggested. The minimax algorithm was used in the development of this chess engine.

In order to play a game strategically, one must anticipate every possible way to win. The standard grading policy for game trees is +1 for winning and -1 for losing, which ultimately aids the agent in choosing the next game. This could need the creation of an entire state space, meaning that each option or course of action must be carefully studied, and the agent should select the one that best meets its needs or gets it closer to its objective. Now, this is the standard brute force strategy, which might be practical for simpler and smaller games like tic-tac-toe, but it is unsuitable for searching in large spaces for complex games with enormous state spaces like checkers or chess on an 8 by 8 board. This encourages us to research an improved and workable technique termed minimax. Rejecting cases that prove useless at the beginning of the search reduces the state space for every move by move.

II. RELATED WORK

The algorithm is brute force search in the state space. A decision-making algorithm is called Minimax [1].The algorithm's primary goal is to determine the following optimum move for the game of Tic-Tac-Toe [2] (application of minimax).The first player is the maximizer in applications of the Minimax algorithm (when there are two players), while the second player is the minimizer. The game board is used to award the evaluation score, and the maximizer and minimizer each try to obtain the highest and lowest scores possible [1].The implementation of the same is displayed in algorithm below [3].

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Other pre-made algorithms are available to create game trees and chess engines based on them. Some engines use these pre-made algorithms that make use of game trees with partial knowledge, where the opponent's next move is occasionally not precisely predicted, leading to the development of disorganised game trees. The game tree must be expanded in order to implement the refresh probability table method, which prevents predictions of this nature[4].

The move is entirely determined by the computer and is based on databases that contain the movements of games played by grandmasters, according to the paper titled "A Genetic Algorithms for Evolving Computer Chess Program." This engine does a 1-ply search, takes into account all movements made at that specific point, and then saves the chosen move. The stored move and the move that was actually executed by the player are then compared. By counting the instances in which both motions are identical, the algorithm's fitness is evaluated. It demonstrates how chess programme parameters are evolved using genetic algorithms. [5]

In the study "Particle Swarm Optimization Applied to the Chess Game," machine learning optimization for weight initialization is discussed (PSO). The paper develops the notion of using piece values more effectively for the safety of the king and centre control. Position value tables or piece square tables based on weights are used to calculate movements that are typically chosen based on opening moves, endgame positions, or piece values in chess publications (values in piece square table). In some circumstances, PSO offers an advantage over static tuned piece square table values.However, it must be taken from static tuning and is very sensitive to initial weights. To get around it, we generate moves from chess books and evaluate initial moves using those moves [6].

III. METHODOLOGY

The two-person game of perfect information uses search strategies to solve problems.A portion of the game-playing tree is often created. Heuristic search, in particular, is constantly utilised, along with blind search, are the typical search approaches. MINIMAX and alpha-beta pruning are two heuristic search methods for the two-person game of perfect information.

In MINIMAX, search terminal nodes represent movements that lead to one of the two players winning the game. Depending on who wins, the value of the node is either 1 or -1. If side A is represented, side A's goal is to go to a node with value 1 while the adversary's goal is to get to a node with value -1.If a game might finish in a draw, we assign nodes that would result in a draw a value of 0. We must weigh all possible outcomes, even those corresponding to internal nodes in the game playing tree, before deciding on our next action. The side B operates in opposition to the side A, which will select the child node with the highest value when deciding how to proceed. Due of the size of the majority of game playing trees, this approach is not practicable.
The algorithm automatically generates mask image without user interaction that contains only text regions to be in painted.

In game theory and decision-making, the mini-max algorithm is a recursive or backtracking method. In the event that the opponent is likewise playing optimally, it offers the player an optimum move.AI game playing often uses the Min-Max algorithm. such as Go, tic-tac-toe, chess, checkers, and many two-player games. The minimax decision for the current state is computed by this algorithm.One player is referred to as MAX and the other is referred to as MIN in this method. The two players compete while they profit the most and the opponent player benefits the least. The game pits two players against one another, with MAX choosing the maximal value and MIN choosing the minimal value. For the investigation of the whole game tree, the minimax method uses a depth-first search strategy. The minimax method descends all the way to the tree's terminal node before recursively going back up the tree.

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Algorithm 1: Minimax Algorithm

```
function minimax(node,depth, maximizingPlayer)
if depth = 0 or node is a leaf node then
    return heuristic value of node
end
if maximizingPlayer then
    value = -∞
    while every child of node do
        value = max(value, minimax(child, depth-1,
          FALSE)
    end
    return value
end
else
    value = +∞
    while every child of node do
        value = min(value, minimax(child, depth-1,
          TRUE)
    end
    return value
end
```

Working of Min-Max Algorithm:

- The method builds the full game-tree in the first phase, then uses the utility function to determine the utility values for each terminal state. Let's assume that state A represents the tree's starting state in the tree diagram below. Let's assume that the maximizer takes the first turn, where the worst-case initial value is zero, and the minimizer takes the following turn, where the worst-case initial value is positive.
- Then, we compare each value in the terminal state with the starting value of the Maximizer to determine the values of the upper nodes. At this point, we have found the utilities value for the Maximizer, and its initial value is -. It will identify the greatest value among all.
- The minimizer is in charge of finding the values of the nodes in the third layer in the following phase, hence it will compare all node values with +∞.
- Now it's Maximizer's time, and it will once more select the highest value among all nodes and determine the highest value for the root node. Since there are just 4 levels in our game tree, we may jump right to the root node. However, there will be more layers in actual games.

A chess game plan is used to implement the search function. One should be familiar with several opening conceptions, like as the Ruy Lopez, Slav defensive, Evan's Gambit, etc., to acquire a superior opening in a chess game. Similar to this, pick the first move from the database of the chess opening book with the intention of obtaining a strong positional opening. This idea is put into practise such that the model must attempt to make the optimal move to block the move of the human player. The theory used by chess Grandmasters from the chess book database will then be the optimal move to make in the opening. The game tree model is generated using the minimax method in the event that the initial moves don't have a follow-up inside the book.

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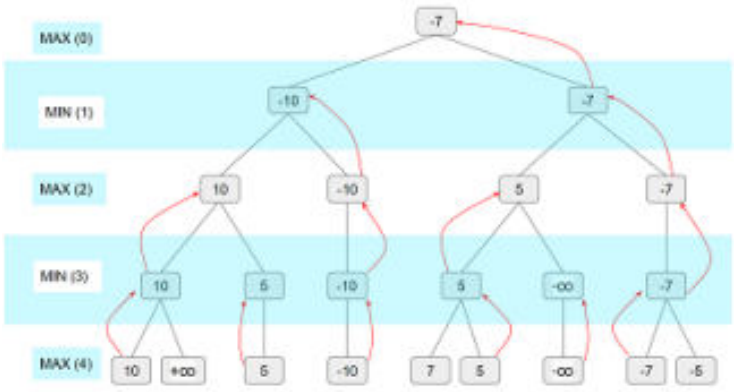
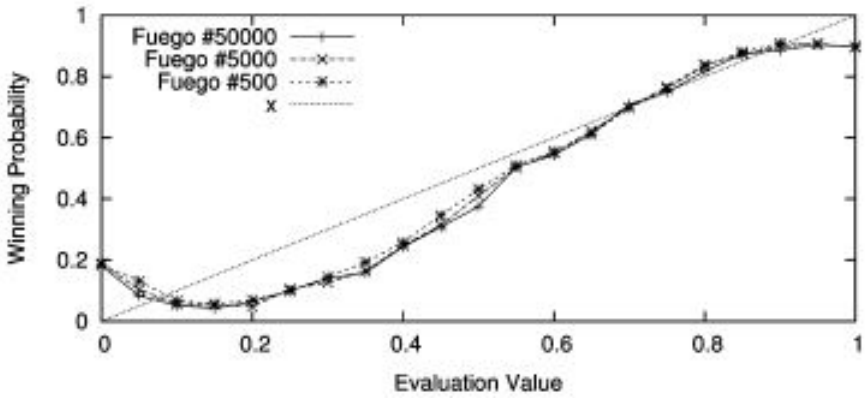


Fig. 3.1. Minimax Algorithm

With a search algorithm and alpha beta pruning, the Minimax method is frequently used. It seeks to lessen the number of nodes in the game tree produced by the minimax algorithm. When the previously played move detects a worse move, the assessment is stopped and the next alternative is evaluated. It might not lead to a loss of the optimal move if the superfluous branches are removed in order to save some calculation performance and power. The end outcome is unchanged. As a result, the algorithm is quick and trustworthy.

IV. EXPERIMENTAL RESULTS

Figures shows the results of text detection from an image and in painting by using exemplar based in paintingus initially provide the findings from trials using Minmax tree search techniques in this section. The examination of evaluation functions for min-max search techniques is where we later demonstrate the effectiveness of our approaches.



From above Fig, it can be inferred that applying beam search optimization will result in an average speed up of 96.28% when compared to the reordering strategy. The number of nodes visited and the execution time are directly related. A less number of nodes visited will result in improved performance. Therefore, compared to reordering optimization, beam search maximises the number of nodes visited.

Due to the same competency of the participants on both sides, the self-play match lasted longer than anticipated. The AI model is used to describe competency in this context. However, the analysis shows that black wins, proving that the model works effectively when played as black. When using the opening movements from chess books, it may be assumed that the initial move made by white is countered by the best move made by black after applying some critical thought to the question of why this is the case.Thus, we draw the conclusion that beam search is the best

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implementation since it achieves the maximum speed up and the lowest number of visited nodes, both of which enhance performance.

V. CONCLUSION

The level of the game tree may be changed to create several modes and difficulty for this straightforward basic chess engine. It can play with any human, any chess engine that is UCI compatible, as well as by itself. As the game progresses, the model continues to improve the movements. Based on the move produced by the adversary, it creates the game tree dynamically and uses evaluation functions to calculate the score. Most engines benefit from increased performance since they are written in high-level languages like C++ and Java. Python executes more slowly than other languages. The computer chess engines still struggle to comprehend some moves, such as endgame fortresses.

The socket and threads might then be used to make it available to everyone, allowing users in various physical locations to enjoy it. In order to make the project appealing and user-friendly, speech recognition can also be used to implement voice-enabled features.

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