

Tic Tac Toe Project: Implement Depth-Limited Minimax for 4x4 Tic-Tac-Toe

Objective: In this project, you will implement a depth-limited version of the minimax algorithm to play 4x4 Tic-Tac-Toe with three difficulty levels: easy, medium, and hard. The difficulty levels are controlled by limiting the depth of the minimax search tree.

Instructions:

1. Game Representation:

- Implement a 4x4 Tic-Tac-Toe board.
- Use 'X' and 'O' as player symbols, where 'X' represents the AI player and 'O' represents the human player.

2. Minimax Algorithm Implementation:

- Implement the minimax algorithm to evaluate the board and determine the best move for the AI.
- Include an evaluation function that assigns scores to states. Implement alpha-beta pruning to optimize the minimax algorithm and compare the performance with and without pruning.

3. Difficulty Levels:

- Easy Level: AI considers fewer moves ahead, making it easier for the human player to win.
- Medium Level: AI looks ahead a few more moves, offering a moderate challenge.
- Hard Level: AI looks even further ahead, making it much more difficult for the human player to outsmart the AI. At this level, the AI will be much more challenging, looking further ahead and making more strategic decisions.

4. Testing:

- Allow the human player to play against the AI with each difficulty level.
- Observe and record the differences in the AI's performance and decision quality for each level.
- Compare the game performance with and without pruning.

5. Evaluation Function:

- Design a heuristic evaluation function for non-terminal states. This function should take into account:
 - Number of potential lines of four for each player.
 - Blocks or threats created by the opponent.

Questions for Reflection:

- How does the depth limit affect the AI's ability to make optimal moves?
- How does increasing the depth affect the computational cost and response time of the AI?
- In which scenarios might a depth-limited minimax still lead to suboptimal play, even at higher depths?

It is recommended to use a Graphical User Interface for the game.

Deliverables:

- Python code to implement the Tic Tac Toe games using the minimax algorithm.
- A brief (maximum 3-minute) video explaining the code implementation and summarizing the results.