Project Title: AI-Enhanced Connect Four Game

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Course: AI
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1. Project Overview

Project Topic:

This project focuses on developing an AI-enhanced version of the classic Connect Four game. The AI will use the Alpha-Beta Pruning technique to make intelligent moves against the human player.

Objective:

The primary goal of this project is to implement an AI-driven opponent that can analyze the game board and predict the best possible moves using Alpha-Beta Pruning. The project will also include a user-friendly graphical interface developed using Pygame.

2. Game Description

Original Game Background:

Connect Four is a two-player strategy game played on a 7x6 vertical grid. Each player drops colored discs into columns, and the objective is to form a sequence of four discs in a row, column, or diagonal before the opponent does.

Innovations Introduced:

- Integration of an AI opponent using Alpha-Beta Pruning for better decision-making.

- A well-designed graphical interface using Pygame for an interactive user experience.

- Possible extension to support networking for remote play.

- Optimization of AI performance by evaluating board states up to a depth of four moves.

3. AI Approach and Methodology

AI Techniques to be Used:

- **Alpha-Beta Pruning:** Used to optimize the Minimax algorithm and speed up decision-making.

- **Heuristic Evaluation Function:** The AI evaluates board states to determine the best move.

- **Tree Search Techniques:** The AI will analyze possible future moves to maximize its chances of winning.

Heuristic Design:

- Assigning scores to board states based on the number of connected discs.

- Blocking opponent moves while optimizing for the AI's winning chances.

Complexity Analysis:

- The game tree expands exponentially, making deeper searches computationally expensive.

- Alpha-Beta Pruning helps reduce unnecessary calculations, optimizing performance.

4. Game Rules and Mechanics

Modified Rules:

- The game remains the same as the original Connect Four but includes an AI opponent.

- The AI will have adjustable difficulty levels based on the depth of its search.

Winning Conditions:

- A player wins by connecting four discs in a row, column, or diagonal.

- If the grid is full without a winner, the game ends in a draw.

Turn Sequence:

- The human player and AI take turns placing discs.

- The AI analyzes the board and places its move intelligently.

5. Implementation Plan

Programming Language:

- Python

Libraries and Tools:

- **Pygame:** For graphical user interface (GUI) development.

- **NumPy:** For efficient data handling and board state management.

- **Alpha-Beta Pruning Algorithm:** To optimize AI decision-making.

Milestones and Timeline:

- **Week 1-2:** Design game mechanics and finalize rules.

- **Week 3-4:** Implement AI strategy (Alpha-Beta Pruning and heuristics).

- **Week 5-6:** Develop the GUI and integrate game logic.

- **Week 7:** Test AI performance and optimize its gameplay.

- **Week 8:** Final testing, debugging, and project report preparation.

6. References

- Connect Four game theory and strategies.

- Research papers on Minimax and Alpha-Beta Pruning algorithms.

- Pygame documentation for game development.