Project Report – AI POWERED CONNECT FOUR PLUS

**Team Members:**

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**1. Project Overview**

Connect Four is a strategic two-player game where players take turns dropping colored discs into a vertical grid. The first player to form a horizontal, vertical, or diagonal line of four of their own discs wins the game.  
  
Our project enhances the classic Connect Four with artificial intelligence and gameplay variations. We implemented multiple AI difficulty levels using Minimax with Alpha-Beta pruning and used a Genetic Algorithm to evolve strategies offline that could consistently beat the AI when followed manually. Additionally, we introduced a novel 'Fog of War' mode, where players can only see their own discs.

**2. Objectives**

• Build a functional and visually polished Connect Four game with AI integration.  
• Implement different AI strategies using Minimax and a Genetic Algorithm.  
• Introduce a new gameplay mechanic (Fog of War) for imperfect information.  
• Provide multiple levels of difficulty and modes for diverse player experience.

**3. Key Features**

• Player vs Player (PvP) mode.  
• Player vs AI with 5 difficulty levels: Easy, Intermediate, Hard, Impossible, Godmode.  
• AI vs AI mode to observe autonomous gameplay.  
• Fog of War mode: hides AI discs from player.  
• Animated disc drops, sound effects, restart and quit controls.

**4. AI Implementation**

We implemented AI using two different approaches:  
  
• Minimax Algorithm: This method recursively explores future game states and selects optimal moves. Alpha-Beta pruning is applied to reduce search space. Heuristic scoring favors center dominance, win chains, and blocks opponent strategies.  
  
• Genetic Algorithm (Offline Strategy Evolution): We used a Genetic Algorithm in a separate script (`genetic.py`) to simulate games and evolve strategies over 500 generations. After training, the best move sequences were extracted. When followed by a human player in-game, these strategies proved highly effective in consistently beating the AI. This approach simulates learning but does not run live during gameplay.

**5. Innovation – Fog of War Mode**

The Fog of War mode hides the opponent’s moves from the player, requiring them to remember and infer positions. It transforms Connect Four into a game of incomplete information, increasing strategic complexity. We controlled board rendering to ensure only the current player's discs are shown during their turn.

**6. Technologies Used**

• Python – main programming language.  
• Pygame – for game rendering and UI.  
• NumPy – matrix and board handling.  
• Gabarito Font – custom UI font.  
• OSS Audio – for game sounds.

**7. Challenges & Solutions**

• Preventing AI disc rendering leaks in Fog of War.  
• Handling AI turn logic and delays without breaking gameplay.  
• Designing scalable heuristics for AI decisions.  
• Training useful strategies through Genetic Algorithms.  
We addressed these using conditional rendering, turn handling, and offline simulations.

**8. Demo Video**

A 2-minute demo video has been created, showcasing:  
• Gameplay in various modes  
• Fog of War functionality  
• AI vs AI demonstration  
Voiceover has been provided by a team member as required.

Link: <https://youtu.be/EDhE7eQHNw4?si=dJG43iuR7Rx_AyvO>

**9. Submission Details**

• Course: Artificial Intelligence  
• Instructor: Miss Mehak Mazhar  
• Deadline: 11th May 2025

**10. Conclusion**

This project gave us valuable hands-on experience in AI development, game design, and innovation. From implementing strategic algorithms to designing new game mechanics, we explored multiple aspects of intelligent systems. The Fog of War mode and offline-trained Genetic strategies helped us understand both game theory and adaptive learning in a practical context.