

**Project Title:**

Reverse Connect 4 – 3 Player Variant

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Course: AI

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**1. Project Overview****● Project Topic:**

Our project is based on the traditional Connect 4 game. We have adapted the game to support three players instead of two. The objective remains the same: to form four of one's own discs in a row (horizontally, vertically, or diagonally).

**● Objective:**

To develop an AI for a 3-player Connect 4 game using the Minimax algorithm with Alpha-Beta pruning, focusing on offensive and defensive strategies to win or prevent others from winning.

**2. Game Description****● Original Game Background:**

Connect 4 is a strategy game where two players take turns dropping discs into a 6x7 grid. The first player to align four of their discs in a row (horizontal, vertical, or diagonal) wins the game.

**● Innovations Introduced:**

- The game is modified to allow 3 players instead of 2.
- Turn-based play in a rotating sequence among three players.
- Game complexity increases with more players and additional decision-making layers.

### ○ Impact on Gameplay:

Each player must plan not only for their own win but also block two opponents simultaneously, leading to more complex and dynamic gameplay.

## 3. AI Approach and Methodology

### ● AI Techniques to be Used:

- Minimax Algorithm adapted for 3-player scenarios.
- Alpha-Beta Pruning to optimize search tree performance.

### ● Heuristic Design:

- Reward moves leading to potential 4-in-a-row setups.
- Penalize moves that allow opponents to win.
- Consider opposing threat levels and blocking strategies.

### ● Complexity Analysis:

The time complexity in worst-case is  $O(b^d)$ , where  $b$  = branching factor (number of columns) and  $d$  = depth. Alpha-Beta pruning can reduce this to  $O(b^{(d/2)})$  in the best case. With 3 players, branching becomes more complex due to more alternate turns.

## 4. Game Rules and Mechanics

### ● Modified Rules:

- 3 players take turns placing discs in columns.
- A player wins by aligning four of their discs.
- Game ends when one player wins, or the board is full.

### ● Winning Conditions:

- The first player to make four in a row wins.

### ● Turn Sequence:

- Player 1 → Player 2 → Player 3 → repeat.

## 5. Implementation Plan

● Programming Language:

Python

● Libraries and Tools:

- NumPy (for board and array handling)

● Milestones and Timeline:

- Week 1-2: Design game board and logic
- Week 3-4: Develop Minimax algorithm for 3 players
- Week 5-6: Implement game logic, win detection, and heuristic functions
- Week 7: Integrate AI and test
- Week 8: Final debugging and documentation

## 6. References

- GeeksforGeeks – Minimax Algorithm
- Wikipedia – Connect 4
- Python official documentation
- Online forums and guides related to game AI