

Abstract

This online Othello web game offers two exciting gameplay modes, providing both strategic depth and competitive fun.

- Single Player Mode: Challenge an AI opponent built using the alpha-beta pruning search algorithm, which enhances decision-making by efficiently evaluating possible moves.
- Player vs. Player Mode: Compete against a friend in real-time through an online multiplayer experience. To deliver smooth and responsive gameplay, this mode utilizes WebSocket technology, ensuring seamless communication between players with minimal latency.

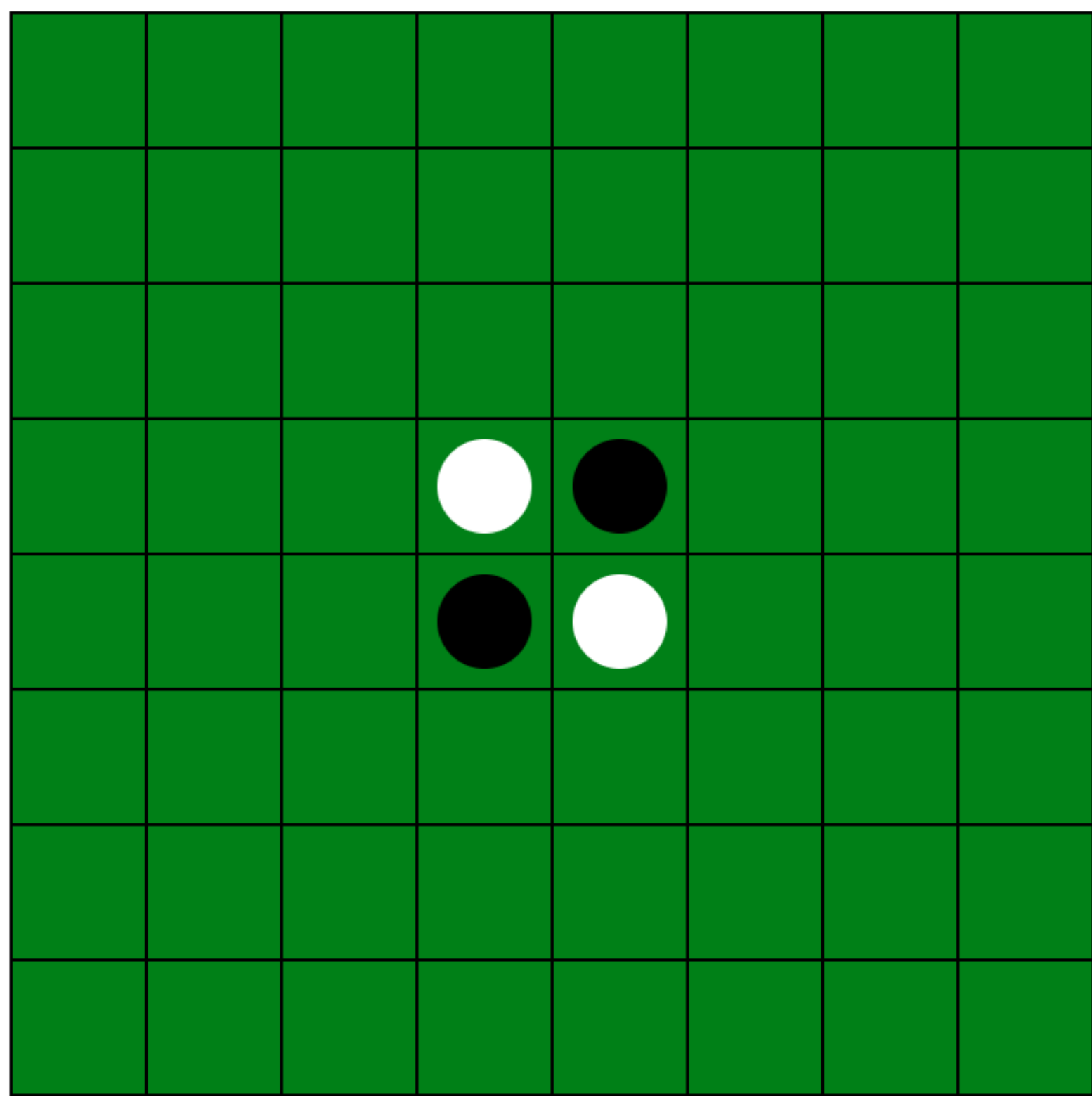


Figure 1. Initial Othello Board.

Basic Rules

Othello is a two-player strategy game played on an 8×8 board with black and white discs. (Figure1.) Players take turns placing their discs to sandwich and flip the opponent’s discs in a straight line (horizontally, vertically, or diagonally).

- A move is valid only if it flips at least one opponent’s disc.
- If a player has no valid moves, they must pass their turn.
- The game ends when neither player can move, and the player with more discs on the board wins.

Protocol

For PvP mode, WebSocket is used to enable real-time, two-way communication between the client and server over a single, persistent TCP (Transmission Control Protocol) connection. This differs from the traditional HTTP request-response model, which requires establishing a new connection for each interaction.

The server creates a room identified by a unique ID and manages its status, including players, the game board, and the current player. Users can either create a room or join an existing room to start PvP mode. If a user chooses to create a room, they receive a unique room ID and are assigned to that room. When another player uses the same ID to join, the game begins.

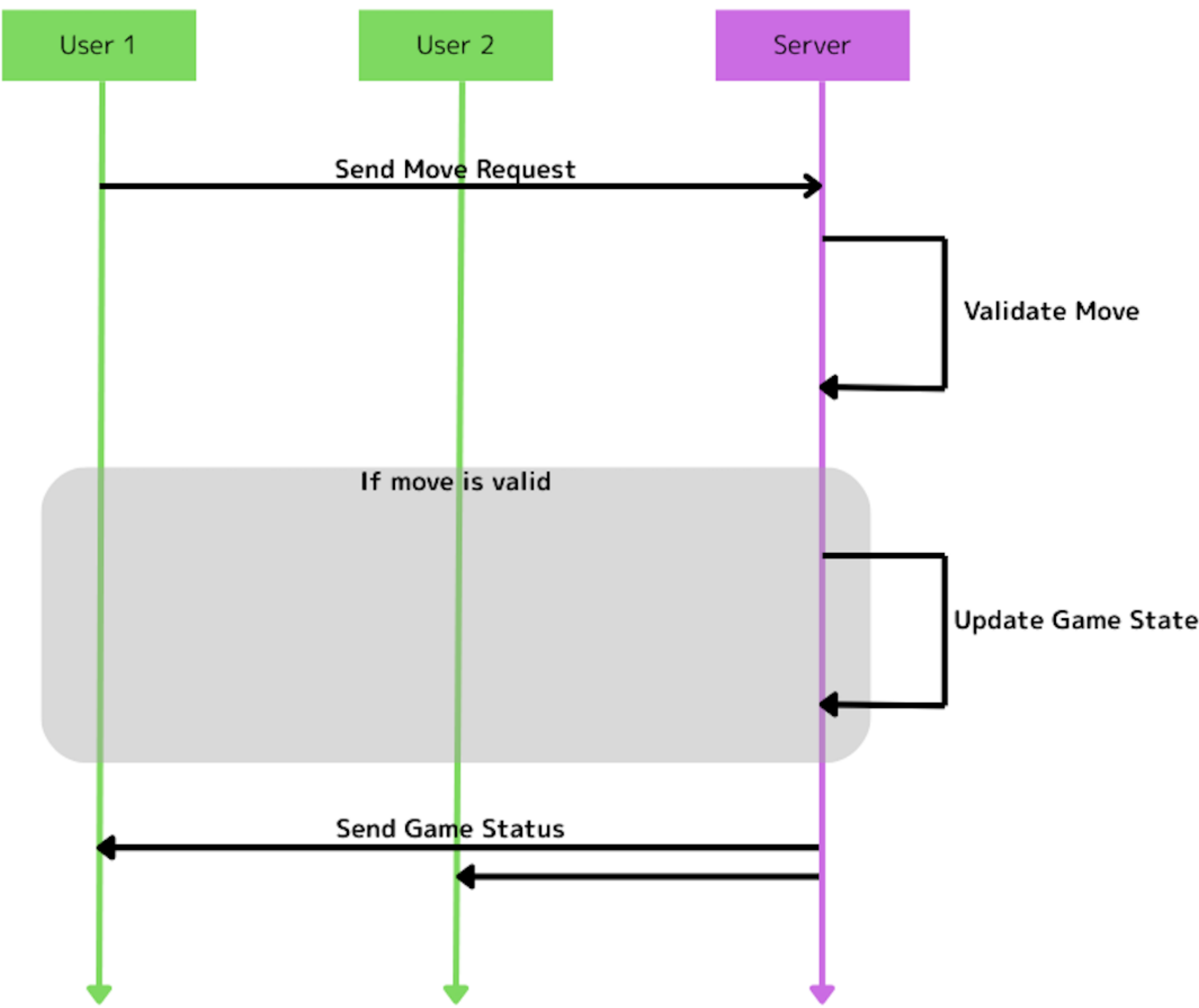


Figure 2. Protocol for the PvP mode.

When the current player selects a move, the user sends the chosen position to the server. The server then verifies whether the move is valid. If valid, the server updates the game state, including the board and the current player, and sends the updated information to both players. (Figure2.) During validation, the server also checks if the game has ended, ensuring proper game management.

AI

In single-player mode, the AI uses the alpha-beta pruning algorithm, an optimized version of minimax. This method assumes the opponent plays optimally and efficiently explores the game tree to evaluate possible outcomes. A heuristic function determines the best move by assigning values to different board states based on four key factors:

- Assign a value to each board position and calculate the total score based on available moves.
- Prioritize corner placement, as these positions are strategically strong.
- Evaluate disc placement in the center, but only during the early stages of the game.
- Count the number of discs on the board in the final stage to assess the advantage.

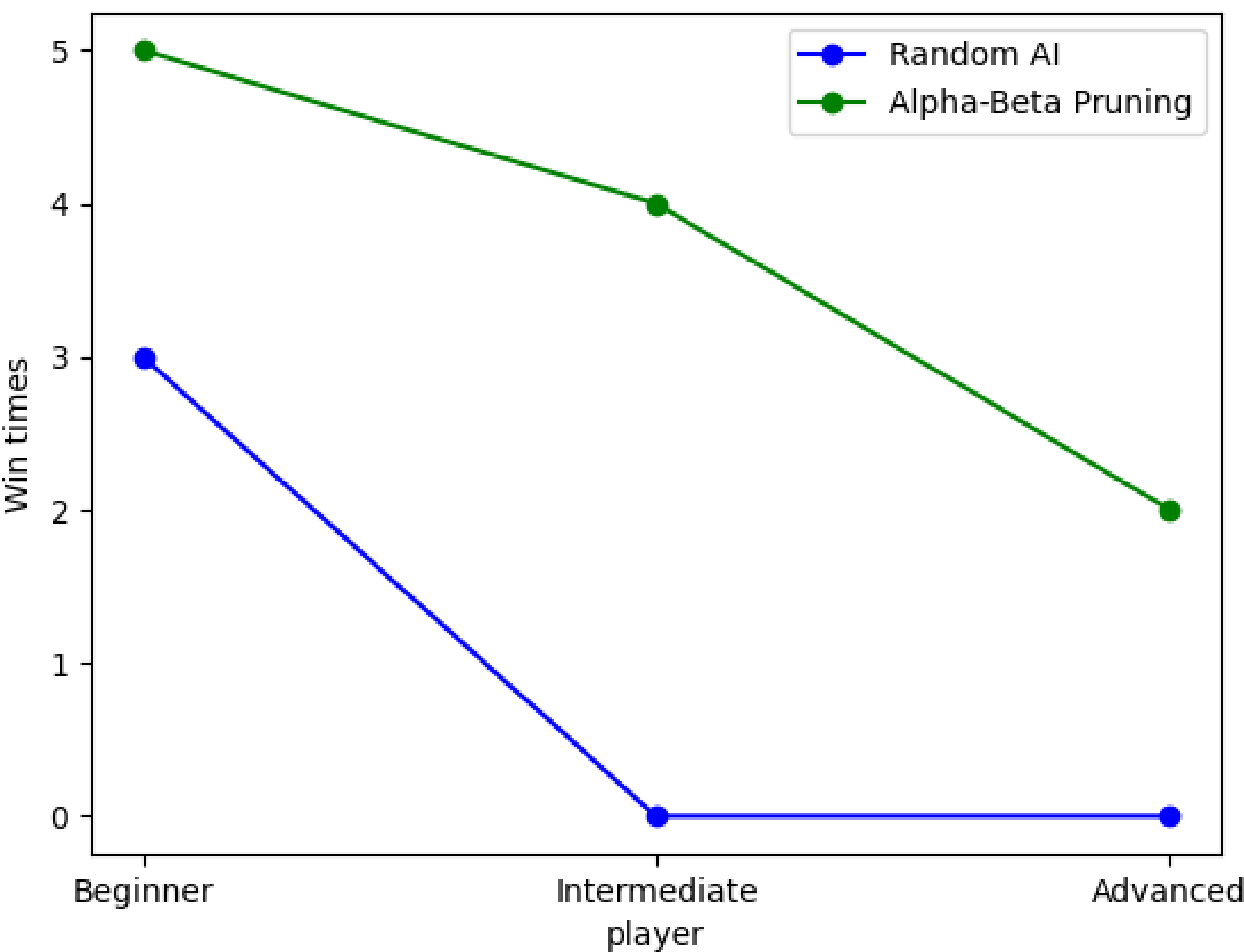


Figure 3. Alpha-Beta AI vs. Random AI

The performance of the alpha-beta pruning AI was evaluated by comparing it to a random AI that selects moves randomly from valid options. Both AIs were tested against beginner, intermediate, and advanced players, with each matchup played five times. (Figure3.) The results showed that the AI consistently outperformed beginners and intermediate players, winning nearly every match. Additionally, the AI's response time was smooth, averaging around three seconds, with the longest response taking seven seconds.