AI: Importance of Sensing Strategies in Reconnaissance Chess Agents

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I. Introduction

The objective of this project was to develop a baseline chess agent using the Reconchess framework, implement enhancements to create an improved agent and then evaluate their performance against each other and reference bots. All the bots, with the exception of RandomBot, use Stockfish as a part of their move selction policy. However, each bot applies a unique sensing strategy. Therefore, this report aims to compare the different bots performance, with a focus on the effect of improvements made to the sensing strategy in the ImprovedAgent.

II. Methodology

Both RandomSensing and ImprovedAgent a combination of move selection strategies, with Stockfish, to reduce the number of possible boards and by extension moves, such as:

- **Majority voting**: Stockfish is used to evaluate possible moves, within a specified timelimit, across the current set of possible boards. The move with the highest aggregate score across all boards is selected.
- **Move filtering**: Before evaluating moves with Stockfish, the valid moves are filtered to a reduced set, where checks and mates are prioritized if found in any possible boards.
- **King Capture**: In the early moves of the game (before move 5), if the enemy king's position has not been confirmed through sensing, the agents assume the king is on the starting square (e1 for white, e8 for black) for move evaluation purposes.
- **Piece-specific strategies**:
  - **Pawns**: Pawn moves are handled separately when updating possible boards after a move. They consider en passant captures and distinguish between pawn captures and non-captures.
  - **Castling**: When updating possible boards for the opponent's move, castling moves are generated if the relevant castling rights are still available.
- **Capture handling**: When an opponent's move results in a capture, the capture square is used to efficiently update the possible boards, considering only moves that could have captured on that square.

These techniques along with those suggested in the instruction document ensure, a manageable number of boards and good move selection, avoiding long runtimes and Stockfish Engine crashes.

III. Sensing Strategy Improvements

The primary enhancement in ImprovedAgent revolves around its sensing strategy. Instead of selecting sensing moves randomly like RandomSensing, ImprovedAgent employs a more robust approach to minimize uncertainty about the opponent's board state. ImprovedAgent's improved sensing strategy works as follows:

1) It calculates the number of unknown pieces for each square on the board based on the current set of possible boards.
2) Then, for each valid sensing square, the total number of unknown pieces across the surrounding 3×3 region is computed.
3) Finally, the sensing square that minimizes the total number of unknown pieces in the 3×3 window is selected.

By targeting the area with the highest uncertainty, ImprovedAgent obtains the most informative sensing result, effectively reducing the number of possible boards more

efficiently than RandomSensing's random approach. This enables ImprovedAgent to develop a clearer image of the opponent's likely board configuration and make better-informed playing moves.

The tournament results demonstrate the impact of this improved sensing strategy, with ImprovedAgent winning the majority of its games against RandomSensing and the other bots. By intelligently selecting sensing moves, ImprovedAgent gains a significant advantage over the baseline agent and performs on par with Troutbot.

IV. Results

To assess performance, a round-robin tournament was conducted involving all four bots. Each bot faced every other bot 20 times, randomly alternating between white and black. As illustrated by the win counts in Figure 1 of each bot.

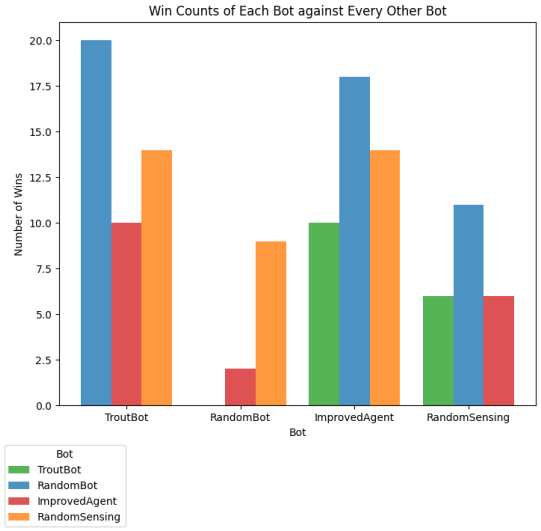

Figure 1. Win counts of each bot

The findings of the tournament are as follows:

- RandomSensing surpassed the reference RandomBot, securing victories in the majority of games both as white and black.
- TroutBot proved superior to RandomSensing, winning 14 out of 20 games, indicating the importance of a strong sensing strategy.
- ImprovedAgent demonstrated strong performance, winning nearly all its games against RandomBot and the majority against RandomSensing and drawing with TroutBot, suggesting the significance of the improved sensing strategy.

The complete game data reveals that ImprovedAgent's average game duration was 1-2 minutes against most bots, while RandomSensing's games often lasted under 1 minute. This suggests that ImprovedAgent's enhanced sensing allowed it to prolong games and make more informed decisions, while still achieving optimal performance.

V. Conclusion

The development of the RandomSensing agent provided a solid foundation for understanding the core aspects of a reconnaissance chess. However, the implementation of an improved sensing strategy in the ImprovedAgent highlighted the significance of strategic sensing in reducing uncertainty and improving overall performance.

By selecting sensing moves that minimize the total number of unknown pieces in the surrounding area, ImprovedAgent can more effectively narrow down the possible board states and make better-informed playing moves. The tournament results underscore the impact of this enhanced sensing approach, with ImprovedAgent outperforming RandomSensing and the other bots.

While there are numerous avenues for further improvement, such as incorporating more chess knowledge into state tracking, the current ImprovedAgent demonstrates the power of strategic sensing in reconnaissance chess. Future work can build upon this foundation to create even more formidable chess agents.