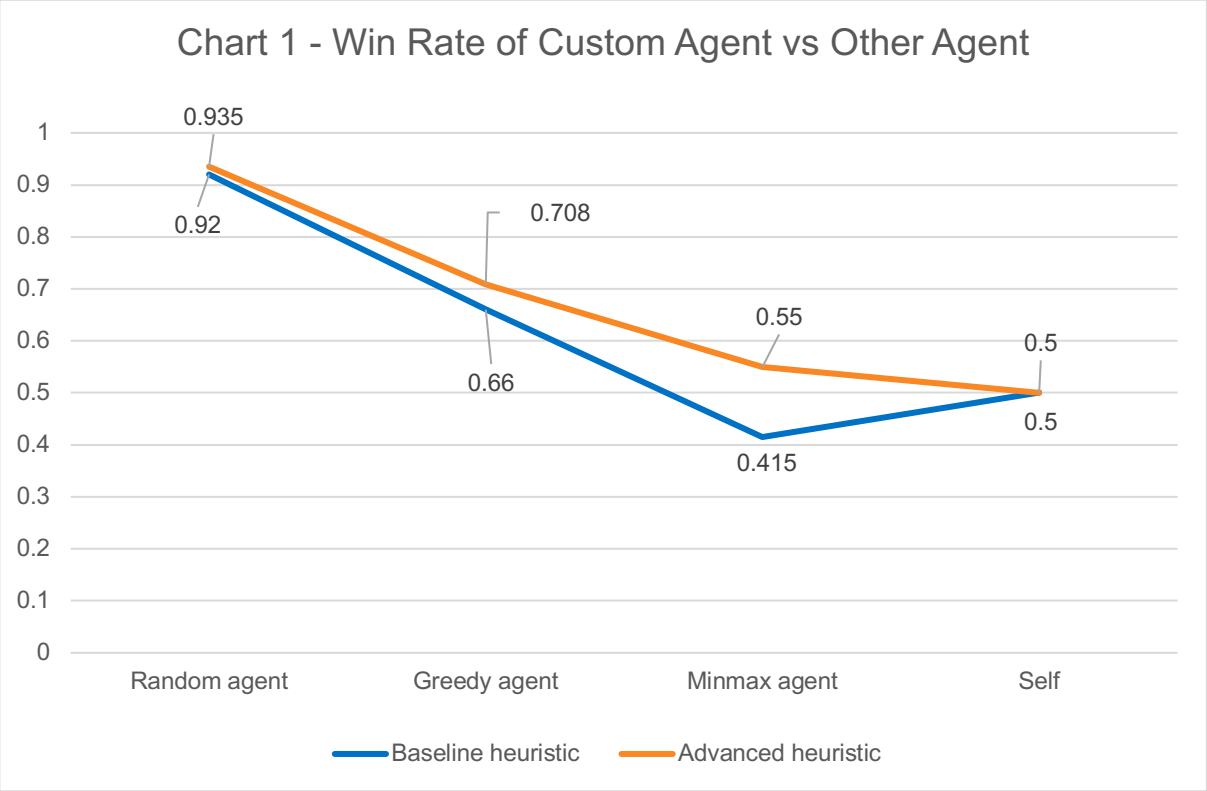
Experimental Results & Report

The report evaluates the performance of the agent using advanced heuristics and opening book.

EXPERIMENT 1 – ADVANCED HEURISTICS

Chart 1 displays the experiment results of custom agent playing against random agent, greedy agent, minmax agent, and itself using advanced heuristic vs baseline heuristic based on a sample of 400 fair matches in a single process. As indicated in Chart 1, except playing games against itself (the rate remains the same), the win rate for the custom agent using advanced heuristics is higher than the one using baseline heuristic.



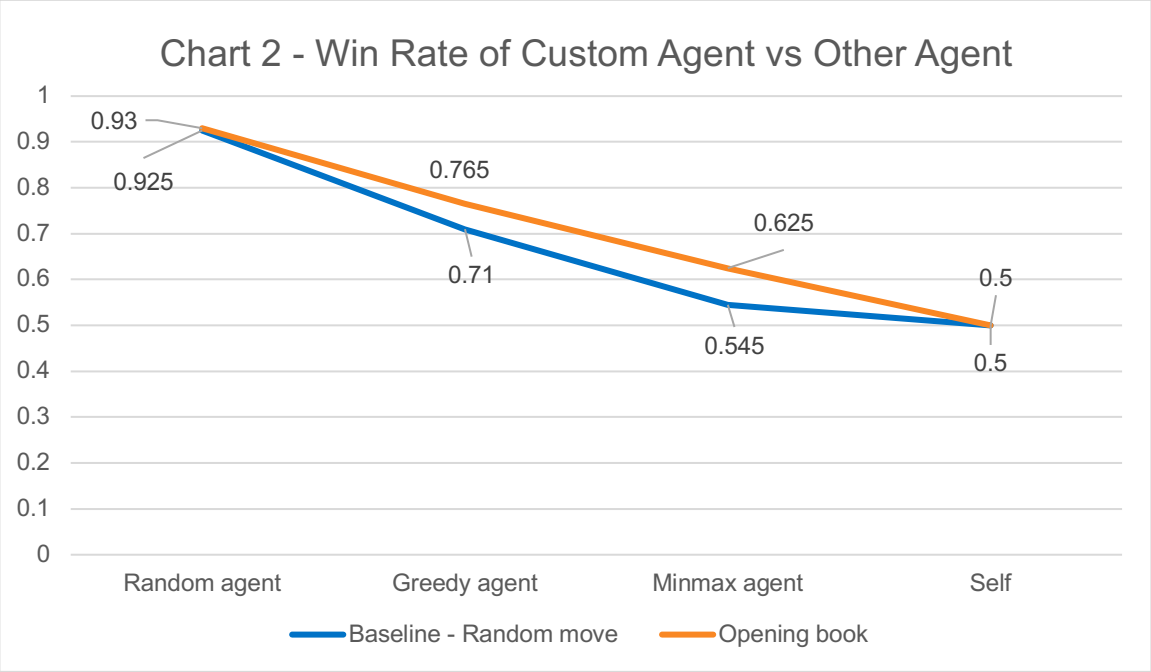
Discussion

1) What features of the game does your heuristic incorporate, and why do you think those features matter in evaluating states during search?

- Baseline Heuristic: #my_moves - #opponent_moves
- Advanced Heuristic: The features including evaluating whether the player is closer to the center of the board and farther way from the border than the opponent, if so, the heuristic uses the difference as a weight to maximize the move, aka opp_distance_to_center - my_distance_to_center + my_distance_to_border – opp_distance_to_border, and uses blank_percentage as a weight for the opponent to minimize opponent's move; if not, use the baseline heuristic
- The idea is that if the player is further away from the walls than its opponent and closer to the center than its enemy, it has more liberties and is in higher staking of winning, so the heuristic uses the extra weight maximizes the chances of winning.
- Increasing the time-out also increases the performance

2) Analyze the search depth your agent achieves using your custom heuristic. Does search speed matter more or less than accuracy to the performance of your heuristic?
   - The agent can achieve search up to depth 10 using my custom heuristic with 150 milliseconds timeout, but the performance drops sharply. Its win rate is 0% against either Greedy, Random, or Minmax agent. The depth limit I set is currently 6, and the custom agent can reach that. In this case, the search speed doesn't matter more than the accuracy to the performance of my heuristic.

EXPERIMENT 2 – OPENING BOOK



Above Chart 2 shows the results of custom agent playing against random agent, greedy agent, minmax agent, and itself using advanced heuristics with random open move vs opening book based on a sample of 200 matches with fair match disabled in a single process. As indicated in Chart 2, except playing games against itself (the rate remains the same), the win rate for the custom agent using openning book is higher than the one with random open moves. Increasing the time out does confer more advantage of using the opening book over random open moves, for example, setting the time limit to 300 milliseconds yields win rate of 66% against minmax agent.

Discussion:

1) Describe your process for collecting statistics to build your opening book. How did you choose states to sample? And how did you perform rollouts to determine a winner?
    - The process begins with simulating the game with alpha-beta pruning agent using advanced heuristics, after achieving depth 4, it simulates as a random agent till the end of the game, then the program collects the wins of each sample game and records the data of actions with most wins for each board state from empty board to a depth of four. The opening book is developed from simulating a sample of 20000 games.

2) What opening moves does your book suggest are most effective on an empty board for player 1 and what is player 2's best reply?
    - The most efficient opening moves on an empty board for player 1 is 112
    - Player 2’s best reply is 99