

Heuristic Analysis

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The heuristics used on this project are vital to its success as they provide the means to choose between the available actions. On the other hand, heuristics are not the only attribute that define the success of the algorithm, as other parameters such as CPU load, max_depth and timeout parameters also affect greatly the agent performance. As this analysis is only about the heuristics considered, max_depth and timeout were set to 3 and 12 respectively, to avoid the agent forfeiting or failing to complete matches but still maintaining good overall scores.

To assess the heuristics, some trials were performed, each with different heuristics. Initially, the results were not constant, what required the number of matches to be increase to 12, as with more matches the results tend to be less affected by issues such as are affected by CPU load and other non-controllable parameters. Also, to improve readability, the results were parametrized by assessing the performance for each heuristic based on the AB_Improved performance.

The following heuristics were considered:

1. **Open move score** or number of moves remaining to the agent: more legal moves should result on more flexibility and greater chance of escaping from tricky situations;
2. **Improved Score** or number of agent's move discounted the adversary's moves: improved version of number 1, this heuristic privileges minimizing the opponent's moves and maximizing the agent's;
3. **Improved Adversary Score** or number of agent's possible moves minus the square of the number of possible moves for the adversary: similar to heuristic number 2, this considers moves for both players but focus on reducing the number of possible moves for the adversary;
4. **Improved Agent Score** or number of agent's possible moves squared minus the number of possible moves for the adversary: like heuristic number 2, this considers moves for both players but focus on increasing the number of possible moves to the agent;
5. **Center Score**: in this heuristic, the score is calculated by considering the distance of the agent from the center of the board;
6. **Center Adversary Score**: This option focus on both approximating the agent to the center of the board and increasing the agent's moves;
7. **Center Agent Score**: This option focus on both approximating the agent to the center of the board and increasing the agent's moves;
8. **Ratio Agent Score**: heuristic based on the ratio between the agent and its adversary's movements;
9. **Ratio Adversary Score**: heuristic based on the ratio between the adversary and the agent's movements.

Figure 1 shows the results for the heuristics score considering the AB_Improved of each round to obtain the pondered score.

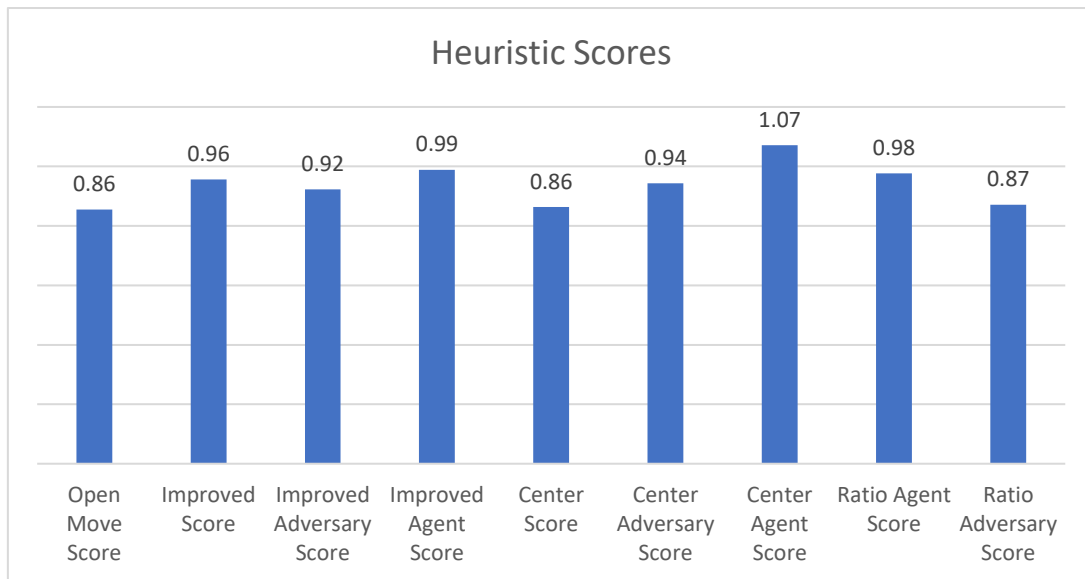


Figure 1 - Results for different heuristics

From the results, we can note that heuristics focusing on the agent rather than on its competitor are more successful. This is probably related to the game's dynamics as trying to reduce the opponent's movements may cause the agent to take moves that won't be as beneficial in the not analyzed future. Also, the good performance of the Center Agent Score allows us to infer that positioning the moves near the center is better, as it probably avoids edges of the boards and other bad regions.

Therefore, the chosen heuristic was **Center Agent Score**, as it was the one with the best win rate, around 7% more than AB_Improved. Although the heuristic is not as simple as some of the others, its run time is not significant to decrease the agent's performance. If a better performance was required, further trials with different depth values would probably yield better results.

Final Code

Considering the results already described, the following score calls are used:

Custom_score: center_agent_score;

Custom_score_2: improved_agent_score;

Custom_score_3: ratio_agent_score.