AIND - Project II

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***Abstract*— This project present a python implementation of an algorithm able to play a two player game of Isolation. This version of isolation constrained moves to L shapes, like knights in chess, and was played in tournaments comparing several heuristics on 7*7 sized board games. This current implementation passed all the unit tests, and by a variation of the heuristic function was able to outperform the ID_improved agent on all tournaments played, although a logistic regression performed on all game data did not show this trend to be significant.**

I. Open Book

This implementation uses a basic open book rule, if player is first to play he takes the center, if he is second to play he takes either the center or the position just underneath if the center is taken.

II. Heuristic comparisons

Our first heuristic was a slightly modified version of the ID_improved, but with a increase amount of aggressiveness represented by a higher weight given to the number of moves available to the opponent.

$$S(a|s) = m_{player} - (ag \times m_{opponent}) \quad (1)$$

$S(a|s)$ is the score for an action a given a certain board state s, and m the number of moves available to the players, ag is a scalar coefficient referred to as the aggressiveness.

Against Random, MM and AB preset algorithms

Exploratory tournament: We performed an initial tournament of 40 matches per round against the other proposed heuristics Random AB and MMs variation. We compared performance of both ID_Improved and our custom heuristic with an aggressiveness of 3. Our custom heuristic performed slightly better than ID_improved with a result in the tournament of 78% versus 73% for ID_improved. To test whether that slight advantage was significant we ran ten such tournaments and used logistic regression to assess of the significance of this advantage using results from all the matches as boolean variables.

Impact of aggressiveness: We tested values of aggressiveness between 1 and 4 in order to understand the possible impact of aggressiveness on the decision. With an aggressiveness of 4, the number of moves left to the player has a very low impact on the decision but might help decide in case of draw. Using aggressiveness as an independent variable in our logistic regression the trend of improved performance against the ID_Improved heuristic (aggressiveness of 1) did not prove to be statistically significant. Bartlett test of homogeneity of variances was non significant, in favor of homogeneous variance across groups with p= 0.87, no significant main effect of aggressiveness on win F(3, 696) = 0.76, p = 0.52 was found with win rate for group ID_improved (N = 280) of 0.66, 95% IC [0.60, 0.71] and win rates for custom heuristic with aggressiveness of 2 (N = 140) of 0.71, 95% IC [0.63, 0.78], for aggressiveness of 3 mean win rate of 0.72, 95% IC [0.65, 0.80] and for aggressiveness of 4 (N = 140) win rate was 0.67, 95% IC [0.59, 0.75]

TABLE I
Number of wins over 40 matches

	ID_improved	Ag3 custom
Random	32	33
MM_Null	27	30
AB_Open	20	27
MM_Improved	22	21
AB_Null	30	33
AB_Open	23	30
AB_Improved	25	22
Win rate	0.73	0.77

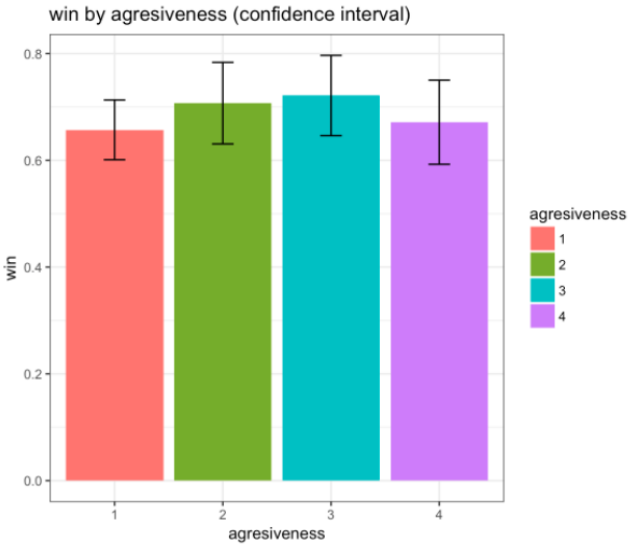

Fig. 1. There exist a slight improving trend of win rate with increasing level of aggressiveness that seems to plateau a aggressiveness of 3. Note that aggressiveness of 1 corresponds to ID_improved

ID_improved against our Custom heuristics

We then proceed to direct competition of the two heuristics against each other.

Impact of aggressiveness: First we tested aggressiveness between values of 2 and 6 in tournament with 80 matches rounds to select the best candidates for a larger competition. Data was extracted from the competition and analyzed as

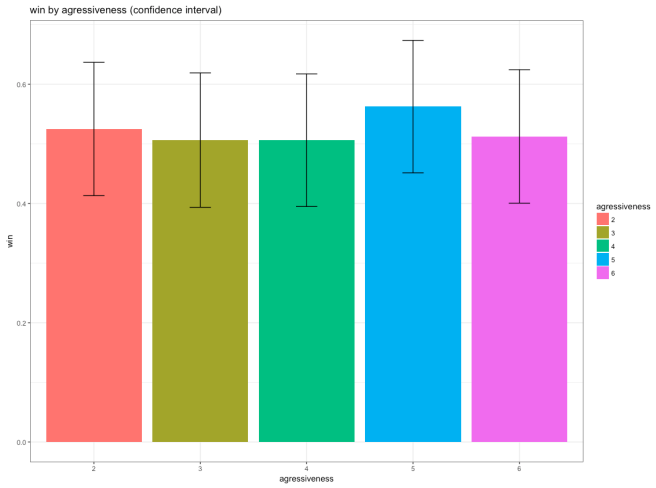

Fig. 2. Win rate of our custom heuristic against ID_improved. Although raw averages are above 50%, this trend is not significant

before using a GLM with logit link, aggressiveness was not found to be a significant predictor of win rate (Wald-test $Z = 0.175$, $P > 0.86$).

TABLE II
WIN RATE OF OUR CUSTOM ALGORITHM AGAINST ID_IMPROVED

Aggressiveness	Win rate [IC 95%]
2 (N = 80)	0.52 [0.41, 0.64]
3 (N = 79)	0.51 [0.39, 0.62]
4 (N = 81)	0.51 [0.39, 0.62]
5 (N = 80)	0.56 [0.45, 0.67]
6 (N = 80)	0.51 [0.40, 0.62]

Large competitions: We then proceed to two large competition of 100 matches per round with aggressiveness of 2 and 3. The results were not conclusive with both algorithm performing slightly equivalently. At aggressiveness of 2, we saw a slight advantage for the custom heuristics at 52.50%, and at aggressiveness of 3 a slight advantage for ID_improved at 52% win rate. These variation around 50% are in favor of an heuristic of similar strength, that was confirmed by insignificant correlation between aggressiveness and win rate using logistic regression.

III. CONCLUSION

This project implemented a basic AI algorithm able to play the game of isolation, using a tree search with iterative deepening, and alpha beta pruning. We tested a custom heuristic derived from the ID_improved heuristic with varying degrees of aggressiveness. A slight trend of improvement was observed for aggressiveness of 2, but although this was not found to be significant using logistic regression, we would recommend using this custom heuristic over the ID_improved one, as it was slightly superior against other proposed heuristics and do not increase computational cost.