Build an Adversarial Game Playing Agent

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Experiment Selected:

Option 1: Develop a custom heuristic

Results:

OPPONENT	# OF MATCHES	TIME LIMIT (ms)	DEPTH	WIN PERCENTAGE	
				BASELINE HEURISTIC	CUSTOM HEURISTIC
Random	200	150	2	93	94
		150	6	94	96.5
		150	10	89.5	89
Greedy	200	150	2	80.5	67.5
		150	6	87.5	90.5
		150	10	77.5	89.5
Minimax	200	150	2	50	56
		150	6	70	85
		150	10	58	73
	40	1000	8	77.5	92.5

Observations:

1. For 150 milliseconds time limit, for each player to make a move, it was identified that depth of ~6 is achievable for my player using baseline heuristic or custom heuristic. Thus, it is observed that my player performs comparatively well against any opponent when a depth limit of 6 is used along with a baseline or custom heuristic.
2. In general, the win percentage of my player against any opponent improved by using custom heuristic when compared with its performance with the baseline heuristic. The only outlier being when the depth limit of 2 is set against the ‘GREEDY’ opponent. In this case, my player with custom heuristics lacks performance when compared with my player using the baseline heuristic. Through some more experimentation, I found that for the depth limit selected (i.e. 2), the aggressive strategy imposed by my custom heuristic of minimizing the remaining opponent moves is proving to be disadvantageous for my player.
3. The more depth that my player is able to achieve since the beginning of the game, the better are the chances of my player winning. But of course, this means the player has to get more time to decide the move. This is shown by an experiment performed by running 40 matches against the ‘MINIMAX’ player (last row of the above table) giving each player 1 seconds to make a move instead of 150 milliseconds. It was identified that a depth of ~8 can be reached with the given time limit. Hence, we see the win percentage substantially increasing for my player using both baseline and custom heuristic.

4. Having a higher depth limit for less time limit is not advantageous but rather resulted in a poor performance of the player. This can be seen by the results for 150 milliseconds time limit with a depth-limit of 10 against any opponent. My player performs worse for depth limit 10 as compared to the depth limit of 6 for 150 milliseconds time limit.

Questions:

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

  The custom heuristic I developed takes into account four factors: legal moves available to my player considering my current location, legal moves available to the opponent considering their current location, all the legal moves available to my player from each action from the current location and all the legal moves available to the opponent from each action from the current location.
  The heuristic I developed is as follows:

$$my\_liberties - 2 * opponent\_liberties + my\_remaining\_liberties - opponent\_remaining\_liberties$$

  There are two considerations while creating this heuristic:

  1. The first part of the heuristic, $my\_liberties - 2 * opponent\_liberties$, incorporates a strategy where my player tries to find moves with the most options while trying to get in the way of the opponent's moves. Also, a bias is added that doubles the weight of the opponent moves and thus encourages my player to attack the opponent more aggressively.
  2. The other part of the heuristic is $my\_remaining\_liberties - opponent\_remaining\_liberties$ and here, my player tries to maximize the remaining legal moves for themself and at the same time tries to minimize the available moves for the opponent thus, trying to corner the opponent on the board.

- *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?*

OPPONENT	TIME LIMIT (ms)	DEPTH ACHIEVED		WIN PERCENTAGE	
		BASELINE HEURISTIC	CUSTOM HEURISTIC	BASELINE HEURISTIC	CUSTOM HEURISTIC
Minimax	150	6	5	72.5	80
	1000	8	7	77.5	92.5

  It is found that search depth achieved using baseline heuristic is one level deeper than the depth achieved with custom heuristic. I suspect this is purely attributed to the increased computation required for calculating the remaining moves for my player and opponent since it incorporates two for-loops to calculate all possibilities.
  The search speed does matter more to my custom heuristics as can be seen in the experimentation results above. The more the search speed, greater depths can be achieved thus increasing the win percentage of my player.