Game-Playing Agent report

I developed 3 heuristics and tested each one for 3 times. Also, I tested the benchmark agent ID_Improved for 3 times. Below is the testing result.

Benchmark: ID_Improved — overall ave: 60.71%

			test 1		test 2		test 3		ave win
			win rate	61.43%	win rate	57.14%	win rate	63.57%	
	evaluatee	opponent	win	lose	win	lose	win	lose	
Match 1	Student	Random	15	5	17	3	19	1	85.00%
Match 2	Student	MM_Null	16	4	13	7	17	3	76.67%
Match 3	Student	MM_Open	9	11	8	12	9	11	43.33%
Match 4	Student	MM_Improved	8	12	10	10	10	10	46.67%
Match 5	Student	AB_Null	15	5	10	10	13	7	63.33%
Match 6	Student	AB_Open	9	11	13	7	12	8	56.67%
Match 7	Student	AB_Improved	14	6	9	11	9	11	53.33%

Heuristic 1 — overall ave: 64.52%

			test 1		test 2		test 3		ave win
			win rate	67.86%	win rate	63.57%	win rate	62.14%	
	evaluatee	opponent	win	lose	win	lose	win	lose	
Match 1	Student	Random	17	3	19	1	18	2	90.00%
Match 2	Student	MM_Null	17	3	15	5	14	6	76.67%
Match 3	Student	MM_Open	9	11	10	10	11	9	50.00%
Match 4	Student	MM_Improved	13	7	10	10	11	9	56.67%
Match 5	Student	AB_Null	11	9	12	8	11	9	56.67%
Match 6	Student	AB_Open	17	3	13	7	12	8	70.00%
Match 7	Student	AB_Improved	11	9	10	10	10	10	51.67%

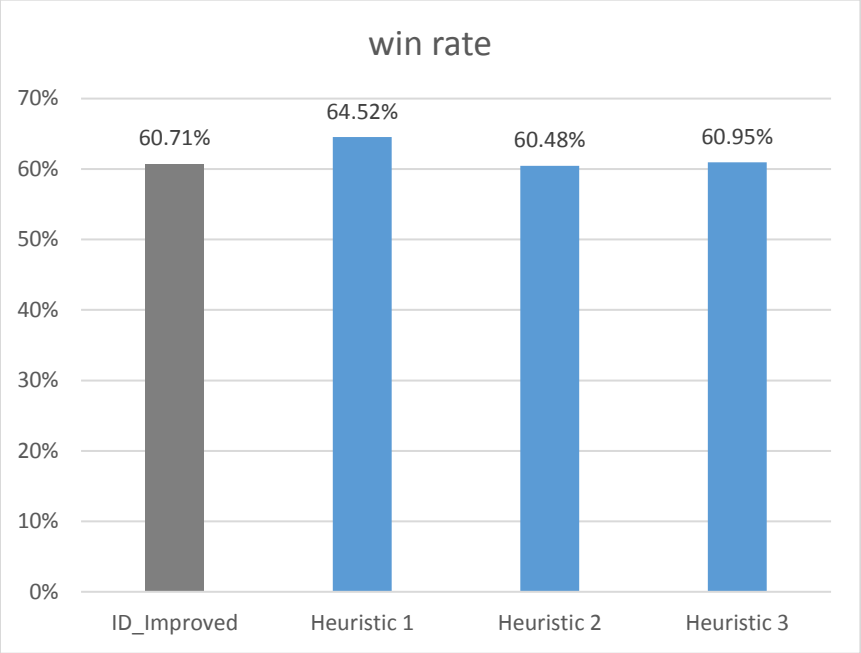
Heuristic 2 — overall ave: 60.48%

			test 1		test 2		test 3		ave win
			win rate	60.71%	win rate	59.29%	win rate	61.43%	
	evaluatee	opponent	win	lose	win	lose	win	lose	
Match 1	Student	Random	17	3	14	6	19	1	83.33%
Match 2	Student	MM_Null	15	5	15	5	15	5	75.00%
Match 3	Student	MM_Open	9	11	11	9	8	12	46.67%
Match 4	Student	MM_Improved	10	10	9	11	12	8	51.67%
Match 5	Student	AB_Null	12	8	13	7	13	7	63.33%
Match 6	Student	AB_Open	10	10	9	11	10	10	48.33%
Match 7	Student	AB_Improved	12	8	12	8	9	11	55.00%

Heuristic 3 — overall ave: 60.95%

			test 1		test 2		test 3		ave win
			win rate	61.43%	win rate	60.71%	win rate	60.71%	
	evaluatee	opponent	win	lose	win	lose	win	lose	
Match 1	Student	Random	16	4	17	3	17	3	83.33%
Match 2	Student	MM_Null	16	4	15	5	15	5	76.67%
Match 3	Student	MM_Open	12	8	9	11	9	11	50.00%
Match 4	Student	MM_Improved	6	14	10	10	10	10	43.33%
Match 5	Student	AB_Null	15	5	12	8	12	8	65.00%
Match 6	Student	AB_Open	10	10	10	10	10	10	50.00%
Match 7	Student	AB_Improved	11	9	12	8	12	8	58.33%

Visualization



Heuristic 1

The heuristic assumes that, for active player, it will enjoy certain advantage when its legal moves overlap with those of its opponent, because this situation means the active player can choose to move to a location that is in the list of opponent's potential moves, and therefore diminish opponent's choices. So I award an extra 1 point to the active player. Other than that, the heuristic is the same as "improved" one.

Performance evaluation:

Its average win rate in 3 tests (67.86%, 63.57%, and 62.14%) is 64.52%. The performance is slightly better than that of the benchmark agent ID_Implemented (60.71%).

This heuristic is consistently better than Random test agent as it wins overwhelmingly in all 3 games (17:3, 19:1, and 18:2). The reason would be that the Random agent does not have a sense of the situation even at the end game, so the Random agent can easily miss out an obvious "checkmate" opportunity (e.g. win in the one ply).

It performs well against MM_Null (76.67%) and AB_Open (70.00%). Facing other opponents, its performance are just slightly above 50%.

Heuristic 2

This heuristic assumes that, it is better stay in the center of the game board. Put another way, need to stay away from boarder and corner. This is because when staying in the center, there are potentially more choices to strategically move to a preferable area. For example, if there are a lot of blank spaces on the right hand side of the board, the player can relatively easily move to that side. For comparison, if the player is at the boarder or corner, it will be harder to get out and move to a preferable side. Other than that, the heuristic is the same as the "Improved" one.

Performance evaluation:

Its average win rate is 60.48%, which is slightly below ID_Improved (60.71%). However the difference should be within error margin.

It consistently outperforms Random opponent, for the same reason mentioned above.

It performs strongly against MM_Null (75.00%). This is because it tries to keep stay in the center area of the board where there is potentially more opportunities. As comparison, MM_Null does not have such sense and can only try to avoid checkmate at the end game, which may be too late.

Heuristic 3

This heuristic is based on "open" version. It adds a further check for a certain scenario where the inactive player only has one legal move, and that one can be immediately occupied by the active player. If this is the case, the active player can choose this step and win. Put another way, this heuristic is looking for a certain scenario where the actively player can win in the next ply. It allows for a quick "peek" at one more ply so as to expand the plies.

Performance evaluation:

Its average win rate is 60.95%, which is slightly above ID_Improved (60.71%). However the difference should be within error margin.

It consistently outperforms Random opponent, for the same reason mentioned above.

It also performs strongly against MM_Null (76.67%). The reason is that it actively seek positions where there is more moves available, so try to maintain good position throughout the game, and give special treatment on checkmate scenario at the extended one more ply. So it is more effective than MM_Null.

Recommended heuristic

I recommend the Heuristic 1. Here are three reasons.

1. Compared to other heuristics and benchmark agent, it performs the strongest against MM_Improved with an average win rate of 56.67%. (Others are 51.67%, 43.33%). This is because it contains all the features of the "Improved" version, and adds an important measure of awarding moves that can reduce opponents' choices.
2. It performs the strongest when facing Random agent. (Ave win rate: 90.00% vs others' 83.33% and 83.33%) This is because it is has a better calculation in end games when players have few choices and the "attack" of reducing opponent's choice is important.
3. It performs the strongest facing Open agent, i.e. both MM_Open (ave win rate: 50.00% vs others' 46.67% and 50.00%) and AB_Open (ave win rate: 70.00% vs others' 48.33% and 50.00%). This is because the heuristic considers both the active player and the inactive player's situations, so is better than the simple Open version which only consider one side of the player.