**Heuristic Analysis**

Among the three custom heuristic functions, open\_first\_plus\_second\_move\_heuristic function has the highest average winning rate as 70% out of 5 tournaments conducted on the same hardware with identical environment variable settings.

The other two heuristic functions, open\_second\_move\_heuristic and improved\_open\_second\_move\_heuristic, have the winning rate of 67% and 61% respectively.

The open\_first\_plus\_second\_move\_heuristic is build base on the idea of open\_move\_heuristic and inject even more knowledge to the heuristic so that the calculation tells more about the game state. It has a stable and outstanding performance toward the random and minimax opponents according to figure 1.

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| --- | --- | --- | --- | --- |
| Win rate% (50 matches) | AlphaBetaPlayer (baseline) | AlphaBetaPlayer w/ open second move heuristic | AlphaBetaPlayer w/ improved open second move heuristic | AlphaBetaPlayer w/ open first + second move heuristic |
| Random | 92% | 90% | 88% | 92% |
| MM\_Open | 66% | 78% | 78% | 86% |
| MM\_Center | 88% | 88% | 82% | 82% |
| MM\_Improved | 66% | 66% | 58% | 86% |
| AB\_Open | 58% | 46% | 38% | 50% |
| AB\_Center | 56% | 50% | 40% | 50% |
| AB\_Improved | 52% | 50% | 44% | 42% |

Figure 1- winning rate of challengers

(100%-80% Green/ 80%-60% Yellow/ 60%-50% Red/<50% Grey)

The open\_first\_plus\_second\_move\_heuristic can be improved by injecting the opponent’s state. But we need to be careful when we add more knowledge to the heuristic function since it makes the calculation heavier at the same time.

Moreover, changing the selection of the heuristic along different stages in the match is also a great idea (similar to human players switching their strategy in the middle of a game).

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