# Build a Game-Playing Agent – Heuristic Analysis

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## Implemented Heuristic

I implemented the following heuristics:

1. **Heuristic Custom\_2:**

Maximize the distance from the other player. (Idea: Move to another area of the board.)

1. **Heuristic Custom\_3:**

Maximize the distance from the other player, but also minimize distance to the center of the board. (Idea: Stay away from corners.)

1. **Heuristic Custom\_4:**

Minimize the distance to the blank fields. (Idea: Move to an area of the board, in which there are lots of blank fields available to increase future choices.)

1. **Heuristic Custom\_5:**

Maximize the open moves available after the next move. (Statically calculate the sum of open moves of all fields the player could move to from the current position.)

1. **Heuristic Custom\_6:**

Maximize the open moves available after the next move. (Statically calculate the sum of open moves of all fields the player could move to from the current position.) Balance it against the moves available to the opponent after the next move (like the improved open move score).

1. **Heuristic Custom\_7:**

Maximize the open moves available after the next move. (Statically calculate the sum of open moves of all fields the player could move to from the current position.) Balance it against the moves available to the opponent after the next move (like the improved open move score). Also consider, that the opponent could move to one of the fields in the next move. The open moves from these fields are not counted.

## Performance Test Results

I implemented the following heuristics:

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | AB\_Improved | Custom\_2 | Custom\_3 | Custom\_4 | Custom\_5 | Custom\_6 | Custom\_7 |
| Random | 19:1 | 16:4 | 14:6 | 15:5 | 16:4 | 18:2 | 18:2 |
| MM\_Open | 14:6 | 13:7 | 12:8 | 9:11 | 8:12 | 14:6 | 15:5 |
| MM\_Center | 14:6 | 17:3 | 15:5 | 11:9 | 17:3 | 18:2 | 16:4 |
| MM\_Improved | 11:9 | 11:9 | 13:7 | 6:14 | 15:5 | 15:5 | 14:6 |
| AB\_Open | 8:12 | 7:13 | 11:9 | 7:13 | 12:8 | 12:8 | 7:13 |
| AB\_Center | 11:9 | 10:10 | 10:10 | 8:12 | 10:10 | 12:8 | 13:7 |
| AB\_Improved | 8:12 | 12:8 | 11:9 | 8:12 | 12:8 | 11:9 | 9:11 |
| Win Rate | 60.7% | 61.4% | 61.4% | 45.7% | 64.3% | 71.4% | 65.7% |

A direct comparison of Custom\_6 and AB\_Improved in 200 matches shows a win rate advantage for Custom\_6 of 56% vs. 44%.

## Recommendation and Discussion

I recommend using Heuristic Custom\_6. Reasons:

1) It follows the same idea as AB\_Improved, but takes the quality of the open fields into account as an additional signal.

2) It constantly seems to be slightly better than AB\_Improved (see data above). A direct comparison of Custom\_6 and AB\_Improved in 200 matches shows a win rate for Custom\_6 of 56.

3) An additional improvement idea of the heuristic (as implemented in Custom\_7) seems to be counter-productive.

The other heuristics (Custom\_2, Custom\_3 and Custom\_4) perform worse than expected. The reason is that the idea behind these heuristics most likely only hold true in large board configurations. In small boards, where both players move around the entire board a lot, the heuristics do not provide enough information. Another reason might be the fact that the heuristics do not consider the state of the match (e.g., if the board is mostly filled up during end game). Considering the state of the match would also be my suggested direction to define and explore additional heuristics.