**Heuristics Comparison**

I choose and implemented 4 heuristics for the project, as well as one control heuristic just for comparison:

Heuristic 1: player’s legal moves \* 1/blank spaces on board

Heuristic 2: player’s legal moves – player’s distance to board’s center

Heuristic 3: opponent’s distance to center – opponent’s legal moves

Heuristic 4: player’s legal moves – 2 \* opponent’s legal moves

Heuristic 5: player’s legal moves (just included for the sake of comparison)

Below are the comparison of their scores in the tournament:

|  |  |  |
| --- | --- | --- |
| **Method** | **ID\_Improved Score** | **Student Score** |
| Heuristic 1 | 70.00% | 65.71% |
| Heuristic 2 | 72.14% | 51.43% |
| Heuristic 3 | 67.14% | 55.71% |
| Heuristic 4 | 74.29% | 78.57% |
| Heuristic 5 (control group) | 69.29% | 61.43% |

I ended up with the **4th heuristic** for 4 main reasons:

1. It scored the highest in the tournament compared to the other three heuristics, as can be seen above. In fact, it was the only one that was able to beat the ID\_Improved agent.
2. It is a lot more consistent against its opponents compared to the other three, as it repeatedly beat its competitors (see the output of the tournaments.py script below)
3. It is simple enough to calculate rapidly, but not so simple that it neglects too much information about the state of the board, as it considers both its own moves as well as those of its competitor
4. And last but not least, it logically makes the most sense: from the perspective of the player, it knows its options, but it doesn’t know what its opponent’s strategy is. Therefore, giving its opponent’s moves more weight while computing its evaluation function makes a lot of sense. Keep your friends close, but your enemies closer.

It is indeed very interesting that the simplest evaluation function I had (option 5) came third. This validates the point from the lectures that simpler evaluation functions can indeed be a lot better than more complex ones, as they can search deeper in the tree in the same amount of time.

**HEURISTIC 1**

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Evaluating: ID\_Improved

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Playing Matches:

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Match 1: ID\_Improved vs Random Result: 16 to 4

Match 2: ID\_Improved vs MM\_Null Result: 13 to 7

Match 3: ID\_Improved vs MM\_Open Result: 16 to 4

Match 4: ID\_Improved vs MM\_Improved Result: 13 to 7

Match 5: ID\_Improved vs AB\_Null Result: 14 to 6

Match 6: ID\_Improved vs AB\_Open Result: 12 to 8

Match 7: ID\_Improved vs AB\_Improved Result: 14 to 6

Results:

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ID\_Improved 70.00%

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Evaluating: Student

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Playing Matches:

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Match 1: Student vs Random Result: 18 to 2

Match 2: Student vs MM\_Null Result: 14 to 6

Match 3: Student vs MM\_Open Result: 10 to 10

Match 4: Student vs MM\_Improved Result: 13 to 7

Match 5: Student vs AB\_Null Result: 14 to 6

Match 6: Student vs AB\_Open Result: 14 to 6

Match 7: Student vs AB\_Improved Result: 9 to 11

Results:

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Student 65.71%

**HEURISTIC 2**

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Evaluating: ID\_Improved

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Playing Matches:

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Match 1: ID\_Improved vs Random Result: 15 to 5

Match 2: ID\_Improved vs MM\_Null Result: 13 to 7

Match 3: ID\_Improved vs MM\_Open Result: 13 to 7

Match 4: ID\_Improved vs MM\_Improved Result: 13 to 7

Match 5: ID\_Improved vs AB\_Null Result: 16 to 4

Match 6: ID\_Improved vs AB\_Open Result: 16 to 4

Match 7: ID\_Improved vs AB\_Improved Result: 15 to 5

Results:

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ID\_Improved 72.14%

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Evaluating: Student

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Playing Matches:

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tournament.py:100: UserWarning: One or more agents lost a match this round due to timeout. The get\_move() function must return before time\_left() reaches 0 ms. You will need to leave some time for the function to return, and may need to increase this margin to avoid timeouts during tournament play.

warnings.warn(TIMEOUT\_WARNING)

Match 1: Student vs Random Result: 18 to 2

Match 2: Student vs MM\_Null Result: 12 to 8

Match 3: Student vs MM\_Open Result: 9 to 11

Match 4: Student vs MM\_Improved Result: 9 to 11

Match 5: Student vs AB\_Null Result: 13 to 7

Match 6: Student vs AB\_Open Result: 8 to 12

Match 7: Student vs AB\_Improved Result: 3 to 17

Results:

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Student 51.43%

**HEURISTIC 3**

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Evaluating: ID\_Improved

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Playing Matches:

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Match 1: ID\_Improved vs Random Result: 16 to 4

Match 2: ID\_Improved vs MM\_Null Result: 15 to 5

Match 3: ID\_Improved vs MM\_Open Result: 13 to 7

Match 4: ID\_Improved vs MM\_Improved Result: 15 to 5

Match 5: ID\_Improved vs AB\_Null Result: 11 to 9

Match 6: ID\_Improved vs AB\_Open Result: 14 to 6

Match 7: ID\_Improved vs AB\_Improved Result: 10 to 10

Results:

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ID\_Improved 67.14%

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Evaluating: Student

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

Playing Matches:

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Match 1: Student vs Random Result: 16 to 4

Match 2: Student vs MM\_Null Result: 11 to 9

Match 3: Student vs MM\_Open Result: 8 to 12

Match 4: Student vs MM\_Improved Result: 13 to 7

Match 5: Student vs AB\_Null Result: 12 to 8

Match 6: Student vs AB\_Open Result: 9 to 11

Match 7: Student vs AB\_Improved Result: 9 to 11

Results:

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Student 55.71%

**HEURISTIC 4**

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Evaluating: ID\_Improved

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Playing Matches:

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Match 1: ID\_Improved vs Random Result: 18 to 2

Match 2: ID\_Improved vs MM\_Null Result: 17 to 3

Match 3: ID\_Improved vs MM\_Open Result: 15 to 5

Match 4: ID\_Improved vs MM\_Improved Result: 14 to 6

Match 5: ID\_Improved vs AB\_Null Result: 16 to 4

Match 6: ID\_Improved vs AB\_Open Result: 11 to 9

Match 7: ID\_Improved vs AB\_Improved Result: 13 to 7

Results:

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ID\_Improved 74.29%

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Evaluating: Student

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Playing Matches:

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Match 1: Student vs Random Result: 20 to 0

Match 2: Student vs MM\_Null Result: 19 to 1

Match 3: Student vs MM\_Open Result: 16 to 4

Match 4: Student vs MM\_Improved Result: 12 to 8

Match 5: Student vs AB\_Null Result: 15 to 5

Match 6: Student vs AB\_Open Result: 16 to 4

Match 7: Student vs AB\_Improved Result: 12 to 8

Results:

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Student 78.57%

**HEURISTIC 5**

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Evaluating: ID\_Improved

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Playing Matches:

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Match 1: ID\_Improved vs Random Result: 17 to 3

Match 2: ID\_Improved vs MM\_Null Result: 16 to 4

Match 3: ID\_Improved vs MM\_Open Result: 12 to 8

Match 4: ID\_Improved vs MM\_Improved Result: 14 to 6

Match 5: ID\_Improved vs AB\_Null Result: 14 to 6

Match 6: ID\_Improved vs AB\_Open Result: 11 to 9

Match 7: ID\_Improved vs AB\_Improved Result: 13 to 7

Results:

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ID\_Improved 69.29%

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Evaluating: Student

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Playing Matches:

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Match 1: Student vs Random Result: 18 to 2

Match 2: Student vs MM\_Null Result: 16 to 4

Match 3: Student vs MM\_Open Result: 10 to 10

Match 4: Student vs MM\_Improved Result: 10 to 10

Match 5: Student vs AB\_Null Result: 12 to 8

Match 6: Student vs AB\_Open Result: 11 to 9

Match 7: Student vs AB\_Improved Result: 9 to 11

Results:

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Student 61.43%