

Build a Game-playing Agent

Results

Heuristic 1

The first heuristic uses the improved score heuristic but also penalises positions in the board where the player is less than 2 squares away from the border. As the movements allowed by the game are L shaped knight movements, the player that gets closer to the border will have less available movements. As the farthest a player can move through an axis with this kind of movement is 2 squares, then the heuristic will reduce the score of a play if the player gets close to the border.

Attempt 1

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Evaluating: ID_Improved
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*****
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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: | 18 | to | 2 |
| Match 3: | ID_Improved | vs | MM_Open | Result: | 13 | to | 7 |
| Match 4: | ID_Improved | vs | MM_Improved | Result: | 11 | to | 9 |
| Match 5: | ID_Improved | vs | AB_Null | Result: | 13 | to | 7 |
| Match 6: | ID_Improved | vs | AB_Open | Result: | 12 | to | 8 |
| Match 7: | ID_Improved | vs | AB_Improved | Result: | 7 | to | 13 |

```
Results:
```

ID_Improved 64.29%

Evaluating: Student

Playing Matches:

| | | | | |
|----------|---------|----|-------------|-----------------|
| Match 1: | Student | vs | Random | Result: 17 to 3 |
| Match 2: | Student | vs | MM_Null | Result: 15 to 5 |
| Match 3: | Student | vs | MM_Open | Result: 12 to 8 |
| 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: 15 to 5 |
| Match 7: | Student | vs | AB_Improved | Result: 12 to 8 |

Results:

Student 70.00%

Attempt 2

Evaluating: ID_Improved

Playing Matches:

| | | | | |
|----------|-------------|----|-------------|-----------------|
| Match 1: | ID_Improved | vs | Random | Result: 14 to 6 |
| Match 2: | ID_Improved | vs | MM_Null | Result: 16 to 4 |
| Match 3: | ID_Improved | vs | MM_Open | Result: 15 to 5 |
| Match 4: | ID_Improved | vs | MM_Improved | Result: 11 to 9 |
| Match 5: | ID_Improved | vs | AB_Null | Result: 13 to 7 |
| Match 6: | ID_Improved | vs | AB_Open | Result: 11 to 9 |
| Match 7: | ID_Improved | vs | AB_Improved | Result: 11 to 9 |

Results:

ID_Improved 65.00%

Evaluating: Student

Playing Matches:

| | | | | |
|----------|---------|----|-------------|-----------------|
| Match 1: | Student | vs | Random | Result: 16 to 4 |
| Match 2: | Student | vs | MM_Null | Result: 15 to 5 |
| Match 3: | Student | vs | MM_Open | Result: 16 to 4 |
| Match 4: | Student | vs | MM_Improved | Result: 14 to 6 |
| Match 5: | Student | vs | AB_Null | Result: 13 to 7 |
| Match 6: | Student | vs | AB_Open | Result: 15 to 5 |
| Match 7: | Student | vs | AB_Improved | Result: 11 to 9 |

Results:

Student 71.43%

Attempt 3

Evaluating: ID_Improved

Playing Matches:

| | | | | |
|----------|-------------|----|-------------|------------------|
| Match 1: | ID_Improved | vs | Random | Result: 13 to 7 |
| Match 2: | ID_Improved | vs | MM_Null | Result: 16 to 4 |
| Match 3: | ID_Improved | vs | MM_Open | Result: 10 to 10 |
| Match 4: | ID_Improved | vs | MM_Improved | Result: 14 to 6 |

| | | |
|-------------------------|-------------|------------------|
| Match 5: ID_Improved vs | AB_Null | Result: 12 to 8 |
| Match 6: ID_Improved vs | AB_Open | Result: 10 to 10 |
| Match 7: ID_Improved vs | AB_Improved | Result: 16 to 4 |

Results:

| | |
|-------------|--------|
| ID_Improved | 65.00% |
|-------------|--------|

Evaluating: Student

Playing Matches:

| | | | | |
|----------|---------|----|-------------|-----------------|
| Match 1: | Student | vs | Random | Result: 16 to 4 |
| Match 2: | Student | vs | MM_Null | Result: 16 to 4 |
| Match 3: | Student | vs | MM_Open | Result: 12 to 8 |
| Match 4: | Student | vs | MM_Improved | Result: 12 to 8 |
| Match 5: | Student | vs | AB_Null | Result: 14 to 6 |
| Match 6: | Student | vs | AB_Open | Result: 13 to 7 |
| Match 7: | Student | vs | AB_Improved | Result: 11 to 9 |

Results:

| | |
|---------|--------|
| Student | 67.14% |
|---------|--------|

Heuristic 2

The second heuristic uses the improved score heuristic but also gives points for positions in the board where the opponent player is less than 2 squares away from the border. Here we use the same logic of being close to the border as a bad thing because of the limitations of the L shaped movement, but this time we give points to branches that could lead to the opponent being close to the border.

Attempt 1

Evaluating: ID_Improved

Playing Matches:

| | | | | |
|----------|-------------|----|-------------|-----------------|
| Match 1: | ID_Improved | vs | Random | Result: 15 to 5 |
| Match 2: | ID_Improved | vs | MM_Null | Result: 14 to 6 |
| Match 3: | ID_Improved | vs | MM_Open | Result: 11 to 9 |
| 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: 11 to 9 |
| Match 7: | ID_Improved | vs | AB_Improved | Result: 12 to 8 |

Results:

ID_Improved 64.29%

Evaluating: Student

Playing Matches:

| | | | | |
|----------|---------|----|-------------|------------------|
| Match 1: | Student | vs | Random | Result: 13 to 7 |
| Match 2: | Student | vs | MM_Null | Result: 19 to 1 |
| Match 3: | Student | vs | MM_Open | Result: 12 to 8 |
| Match 4: | Student | vs | MM_Improved | Result: 11 to 9 |
| Match 5: | Student | vs | AB_Null | Result: 16 to 4 |
| Match 6: | Student | vs | AB_Open | Result: 14 to 6 |
| Match 7: | Student | vs | AB_Improved | Result: 10 to 10 |

Results:

Student

67.86%

Attempt 2

Evaluating: ID_Improved

Playing Matches:

| | | | | |
|----------|-------------|----|-------------|-----------------|
| Match 1: | ID_Improved | vs | Random | Result: 17 to 3 |
| Match 2: | ID_Improved | vs | MM_Null | Result: 15 to 5 |
| 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: 13 to 7 |
| Match 7: | ID_Improved | vs | AB_Improved | Result: 13 to 7 |

Results:

ID_Improved 73.57%

Evaluating: Student

Playing Matches:

| | | | | |
|----------|---------|----|-------------|-----------------|
| Match 1: | Student | vs | Random | Result: 19 to 1 |
| Match 2: | Student | vs | MM_Null | Result: 13 to 7 |
| Match 3: | Student | vs | MM_Open | Result: 15 to 5 |
| Match 4: | Student | vs | MM_Improved | Result: 15 to 5 |
| Match 5: | Student | vs | AB_Null | Result: 17 to 3 |
| Match 6: | Student | vs | AB_Open | Result: 14 to 6 |
| Match 7: | Student | vs | AB_Improved | Result: 13 to 7 |

Results:

Student 75.71%

Attempt 3

Evaluating: ID_Improved

Playing Matches:

| | | | | |
|----------|-------------|----|-------------|------------------|
| Match 1: | ID_Improved | vs | Random | Result: 17 to 3 |
| Match 2: | ID_Improved | vs | MM_Null | Result: 10 to 10 |
| Match 3: | ID_Improved | vs | MM_Open | Result: 10 to 10 |
| Match 4: | ID_Improved | vs | MM_Improved | Result: 10 to 10 |
| Match 5: | ID_Improved | vs | AB_Null | Result: 12 to 8 |
| Match 6: | ID_Improved | vs | AB_Open | Result: 13 to 7 |
| Match 7: | ID_Improved | vs | AB_Improved | Result: 10 to 10 |

Results:

ID_Improved 58.57%

Evaluating: Student

Playing Matches:

| | | | | |
|----------|---------|----|-------------|-----------------|
| Match 1: | Student | vs | Random | Result: 17 to 3 |
| Match 2: | Student | vs | MM_Null | Result: 14 to 6 |
| Match 3: | Student | vs | MM_Open | Result: 12 to 8 |
| Match 4: | Student | vs | MM_Improved | Result: 14 to 6 |
| Match 5: | Student | vs | AB_Null | Result: 14 to 6 |

| | | | | |
|----------|---------|----|-------------|-----------------|
| Match 6: | Student | vs | AB_Open | Result: 12 to 8 |
| Match 7: | Student | vs | AB_Improved | Result: 12 to 8 |

Results:

| | |
|---------|--------|
| Student | 67.86% |
|---------|--------|

Heuristic 3

The last heuristic is a combination of the two previous heuristics. Uses the improved score heuristic along with the points given and taken away depending on how close to the border is the the player and the opponent player.

Attempt 1

Evaluating: ID_Improved

Playing Matches:

| | | | | |
|----------|-------------|----|-------------|-----------------|
| 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: 14 to 6 |
| Match 4: | ID_Improved | vs | MM_Improved | Result: 15 to 5 |
| Match 5: | ID_Improved | vs | AB_Null | Result: 15 to 5 |
| Match 6: | ID_Improved | vs | AB_Open | Result: 13 to 7 |
| Match 7: | ID_Improved | vs | AB_Improved | Result: 14 to 6 |

Results:

| | |
|-------------|--------|
| ID_Improved | 75.71% |
|-------------|--------|

Evaluating: Student

Playing Matches:

| | | | | |
|----------|---------|----|-------------|-----------------|
| Match 1: | Student | vs | Random | Result: 15 to 5 |
| Match 2: | Student | vs | MM_Null | Result: 16 to 4 |
| Match 3: | Student | vs | MM_Open | Result: 15 to 5 |
| 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: 12 to 8 |

Results:

Student 70.71%

Attempt 2

Evaluating: ID_Improved

Playing Matches:

| | | | | |
|----------|-------------|----|-------------|-----------------|
| Match 1: | ID_Improved | vs | Random | Result: 17 to 3 |
| 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: 13 to 7 |
| Match 5: | ID_Improved | vs | AB_Null | Result: 14 to 6 |
| Match 6: | ID_Improved | vs | AB_Open | Result: 14 to 6 |
| Match 7: | ID_Improved | vs | AB_Improved | Result: 13 to 7 |

Results:

ID_Improved 70.71%

Evaluating: Student

Playing Matches:

| | | | | |
|----------|---------|----|-------------|-----------------|
| Match 1: | Student | vs | Random | Result: 17 to 3 |
| Match 2: | Student | vs | MM_Null | Result: 16 to 4 |
| Match 3: | Student | vs | MM_Open | Result: 12 to 8 |
| Match 4: | Student | vs | MM_Improved | Result: 14 to 6 |
| Match 5: | Student | vs | AB_Null | Result: 15 to 5 |
| Match 6: | Student | vs | AB_Open | Result: 13 to 7 |
| Match 7: | Student | vs | AB_Improved | Result: 12 to 8 |

Results:

Student 70.71%

Attempt 3

Evaluating: ID_Improved

Playing Matches:

| | | | | |
|----------|-------------|----|-------------|------------------|
| Match 1: | ID_Improved | vs | Random | Result: 15 to 5 |
| Match 2: | ID_Improved | vs | MM_Null | Result: 17 to 3 |
| 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: 13 to 7 |
| Match 7: | ID_Improved | vs | AB_Improved | Result: 10 to 10 |

Results:

ID_Improved 69.29%

Evaluating: Student

Playing Matches:

| | | | | |
|----------|---------|----|-------------|-----------------|
| Match 1: | Student | vs | Random | Result: 15 to 5 |
| Match 2: | Student | vs | MM_Null | Result: 16 to 4 |
| Match 3: | Student | vs | MM_Open | Result: 16 to 4 |
| Match 4: | Student | vs | MM_Improved | Result: 13 to 7 |
| Match 5: | Student | vs | AB_Null | Result: 17 to 3 |
| Match 6: | Student | vs | AB_Open | Result: 14 to 6 |
| Match 7: | Student | vs | AB_Improved | Result: 14 to 6 |

Results:

Student 75.00%

Conclusions

The table below shows a summary of the results produced by the three heuristics.

| Heuristic | Attempt | Improved | Student | | Average |
|-----------|---------|----------|---------|----------|---------|
| 1 | 1 | 64.29% | 70.00% | Improved | 64.76% |
| | 2 | 65.00% | 71.43% | Student | 69.52% |
| | 3 | 65.00% | 67.14% | | |
| 2 | 1 | 64.29% | 67.86% | Improved | 65.48% |
| | 2 | 73.57% | 75.71% | Student | 70.48% |
| | 3 | 58.57% | 67.86% | | |
| 3 | 1 | 75.71% | 70.71% | Improved | 71.90% |
| | 2 | 70.71% | 70.71% | Student | 72.14% |
| | 3 | 69.29% | 75.00% | | |

As we can see in the results, all of the heuristics performed better than the ID_Improved heuristic although they rely heavily in the improved score heuristic. The additional computations made on each of the heuristics do not represent a lot of work to be made by the agent, so they don't add a burden to the calculation of the heuristic.

As the three heuristics are based on the improved score heuristic, we see that the results are not that different from the improved score heuristic tests, but we can see that overall an improvement exists over the base heuristic. We see that in average the last heuristic performed better than the others, including the improved score heuristic so the recommendations would be to use the heuristic 3. The reasons for this are:

- First of all, it is based on a already good heuristic that compares the available moves by the player. The results show there is not a big difference between the results of the improved score heuristic.
- All the test for the third heuristic yielded a win average above 70%, compared to the results for all other heuristics, this one had a better performance
- If we look at the results of ID_Improved for the third heuristic, we see better results compared to the previous two heuristics, but still the last heuristic produces better results overall.

Because of this results, we should choose heuristic 3 over the other

heuristics.