**Heuristic Analysis**

**1. Description of heuristics**

I’ve analyzed the following heuristics:

**1.0. Basic heuristic.**

Heuristic from the lecture: number of own legal moves minus number of opponents legal moves. It is used as a baseline and as a part of more complex heuristics.

**Function in code**: *basic\_score*

**1.1. Distance from center**

**Assumption**: in cases, where basic heuristic is equal, it is better to be closer to the center of the field.

**Function in code**: *strategy\_center*

**1.2. Distance from opponent**

**Assumption**: in cases, where you have more legal moves, it is better to be closer to your opponent. Else, you’d better be far from him

**Function in code**: *strategy\_close\_or\_far*

**1.3. Be closer to a blank spaces**

**Assumption**: you should choose a place with a minimum sum of distances to blank spaces

**Function in code**: *strategy\_free\_field*

**1.4. Be closer to a blank spaces**

A modification of 1.1.

**Assumption**: in cases, where basic heuristic is equal, it is better to be closer to the center of the field than your opponent

**Function in code**: *strategy\_closer\_to\_center*

**2. Individual heuristic tests**

In the individual test custom\_score simply equal heuristic. Tournament.py is modified to play more games (NUM\_MATCHES = 20)

The results of the individual tests are shown in the table.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Heuristic | ID\_Impoved | Student | delta | Comment |
| basic\_score | 62,50% | 62,70% | 0,20% | Expected to be nearly equal |
| strategy\_center | 61,61% | 66,43% | 4,82% |  |
| strategy\_close\_or\_far | 64,64% | 67,86% | 3,22% |  |
| strategy\_free\_field | 62,86% | 60,89% | -1,97% |  |
| strategy\_closer\_to\_center | 64,46% | 68,39% | 3,93% |  |

The results show that most of the heuristics are a bit better than basic score. Anyhow there is no “star” heuristic. Further improvements are needed.

**3. Stage-based tests**

It is possible, that some heuristics are better at the beginning of the game, and some at the end.

I’ve implemented complex heuristic, which uses different heuristic functions at the different stages of the game:

**def strategy\_complex(game, player):**

*# Begginning of the game*

if len(game.get\_blank\_spaces()) > game.width\*game.height\*0.7:

score = <*heuristic1>*

*# Game middle*

elif len(game.get\_blank\_spaces()) > game.width\*game.height\*0.4:

score = <*heuristic2>*

*# Game ending*

else:

score = <*heuristic3>*

return score

Table shows performance of different heuristics at different stages

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Heuristics** | **Stage** | **ID\_Impoved** | **Student** | **delta** |
| **strategy\_center** | Beginning[[1]](#footnote-1) | 61,61% | 62,50% | 0,89% |
| Middle[[2]](#footnote-2) | 60,9% | 64,56% | 3,66% |
| Ending | 63,04% | 64,29% | 1,25% |
| **strategy\_close\_or\_far** | Beginning | 63,21% | 63,93% | 0,72% |
| Middle | 64,82% | 63,04% | -1,78% |
| Ending | 61,96% | 63,39% | 1,43% |
| **strategy\_free\_field** | Beginning | 63,04% | 65,54% | 2,50% |
| Middle | 64,46% | 62,68% | -1,78% |
| Ending | 61,07% | 61,96% | 0,89% |
| **strategy\_closer\_to\_center** | Beginning | 61,96% | 59,82% | -2,14% |
| Middle | 63,39% | 66,61% | 3,22% |
| Ending | 62,14% | 59,82% | -2,32% |

**Strategy\_center** looks good at the middle of the game and possibly **strategy\_free\_field** looks good at the beginning.

Lets try to combine it to complex heuristic:

At the beginning - **strategy\_free\_field**, at the middle - **strategy\_center** and at the end – **basic strategy**.

The results are: 63,75% for ID\_Improved, 64,64% for Student. Not very impressive.

**4. Re-check of “strategy\_center” heuristics**

**Strategy\_center** heuristics for now looks preferable, but does it consequently outperforms ID\_Improved? To be confident I repeat a measurement with it again. The results are shown in the table:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Heuristic | ID\_Impoved | Student | delta | Comment |
| strategy\_center | 61,61% | 66,43% | 4,82% | Previous measurement |
| strategy\_center | 61,07% | 63,93% | 2,86% | New measurement |

**5. Summary**

1. It seems that an error in measurements is rather big. To reduce errors it is possible to increase NUM\_MATCHES even more. For now, it is impossible due to the project deadline time limit.

2. For now, I choose **strategy\_center** as a preferable heuristic because**:**

* it consequently outperforms ID\_Improved (in fact it basics on the same heuristic, but with an improvement);
* it is easy to implement and compute, so it doesn’t reduce the depth of the search too much;
* it can be reasonably used for other variations of Isolation game (not only for Knight movements).

1. it means that I use strategy\_center at the beginning, and strategy\_basic at the middle and end. [↑](#footnote-ref-1)
2. It means that I use strategy\_center in the middle, and strategy\_basic at the beginning and end. Etc. [↑](#footnote-ref-2)