**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 1.

Table 1. Individual tests

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| 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 | 61,61% | 62,50% | 0,89% |
| Middle | 60,54% | 68,04% | 7,50% |
| 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 | 63,75% |  | 0,00% |
| Ending |  |  | 0,00% |

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: