**For zero knowledge Player vs AI:**

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Heuristic\  Depth | H1 | | H2 | | H3 | | H4 | | H5 | | H6 | |
| wins | Avg.mov | wins | Avg.mov | wins | Avg.mov | wins | Avg.mov | wins | Avg.mov | wins | Avg.mov |
| 0 | 39% | 43.39 | 36% | 44.02 | 35% | 46.15 | 34% | 43.47 | 44% | 45.72 | 44% | 42.46 |
| 1 | 88% | 31.48 | 69% | 31.8 | 79% | 31.11 | 76% | 33.53 | 74% | 32.49 | 74% | 30.47 |
| 2 | 96% | 33.12 | 95% | 35.48 | 97% | 35.91 | 98% | 36.64 | 97% | 34.39 | 97% | 36.6 |
| 3 | 99% | 33.15 | 98% | 36.96 | 95% | 35.77 | 95% | 34.03 | 99% | 33.63 | 99% | 32.0 |
| 4 | 99% | 30.88 | 100% | 33.55 | 99% | 31.71 | 98% | 34.22 | 99% | 32.22 | 99% | 29.72 |
| 5 | 99% | 31.22 | 99% | 32.67 | 100% | 32.56 | 98% | 34.45 | 99% | 32.32 | 99% | 30.02 |
| Average | 86.67% | 33.87 | 82.83% | 35.74 | 84.167% | 35.535 | 83.167% | 35.056 | 85.33% | 35.128 | 85.33% | 33.545 |

Here we have simulated the mancala game played between 2 players, where one player is playing with zero knowledge and the other player is using AI. Here, we see the statistics of AI player win percentage, and the average number of moves to end the game without move ordering.  
  
With move ordering, the number of steps needed to end the game little bit less than without move ordering. I would say, it is kind of 5-10% fast than before. So, move ordering has not much effect in this regard.

With move ordering, the average number of steps needed for heuristic 1, 2, 3, 4, 5, and 6 are 35.57, 33.71, 32.855, 33.9867, 33.961, 33.4967 respectively.

Here we can rank the heuristic values in regard of win percentage of AI. H1 is first, H5 and H6 are both second, H3 is third, H4 is fourth and H2 is last. So here, H1 works best.

**For AI vs AI:**

Here, I have tried every combination of heuristic values with player 1 and player 2. For a certain depth value, the win percentage of player 1 is 47.22% and for player 2 it’s also 47.22% and the number of games tied is 5.56%. And, If the depth is not fixed, then it can be seen the win percentage becomes higher for the player with the greater depth value. The ratio is then changed by 70-75% and 20-25%.

And I think Heuristic 3 and Heuristic 4 works more effectively than the other heuristics. Heuristic 1 is not so bad. It works also fine.

And with move ordering the process becomes little bit fast. But , It doesn’t really put much impact.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Player 1  Using Heuristic | Player 2  Using Heuristic | Player 1  Win percentage | Player 1  Lose percentage | Game tied |
| 1 | All 6’s | 33.33% | 50% | 16.67% |
| 2 | All 6’s | 50% | 50% | 0% |
| 3 | All 6’s | 50% | 50% | 0% |
| 4 | All 6’s | 50% | 33.33% | 16.67% |
| 5 | All 6’s | 50% | 50% | 0% |
| 6 | All 6’s | 50% | 50% | 0% |