**Udacity Artificial Intelligence Nanodegree –**

**Adversarial Game Playing Agent**

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This report evaluates different search algorithms used for adversarial game playing agent in the game of “Knights Isolation”. Refer to the github repository for programming code, readme with problem description. <https://github.com/cristiandatum/AI_projects.git>

The game playing agent algorithm was modified to beat the opponents highest rated algorithm: mini-max with random opening move.

Different configurations and game opening strategies were evaluated. These were tested by creating different Classes (CustomPlayer\_#). The configuration used in the different Classes and the results are summarised in this Table.

1. Results & Discussion

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| **#** | **Strategy** | **Result % (#games)** | **Review** |
| 0 | Algorithm: mini-max with  alpha-beta pruning  Initial depth = 3  Followed by iterative deepening in range: 4 to 9 in steps of size 1.  Opening 1st and 2nd move:  move 1: opponent (random); move 2: me (random) | 49 (100 games) | This configuration is the **base case** from which minor adjustments are made to see if the algorithm is improved. |
| 1 | Algorithm: mini-max with  alpha-beta pruning  Initial depth = 3  Followed by iterative deepening in range: 4 to 9 in **steps of size 2**.  Opening 1st and 2nd move:  move 1: opponent (random); move 2: me (random) | 44 (100 games) | Increasing the speed of iterative deepening does not appear to result in a positive impact. |
| 2 | Algorithm: mini-max with  alpha-beta pruning  Initial depth = 3  Followed by iterative deepening in range: 4 to 9 in steps of size 1.  Opening 1st and 2nd move:  **move 1: CustomPlayer (cell 0);** move 2: Opponent (random) | 50 (100 games) | If CustomPlayer starts, starting from a corner square (cell 0) appears to be a good move. |
| 3 | Algorithm: mini-max with  alpha-beta pruning  Initial depth = 3  Followed by iterative deepening in range: 4 to 9 in steps of size 1.  Opening 1st and 2nd move:  **move 1: CustomPlayer (cell 1);** move 2: Opponent (random) | 44 (100 games) | If CustomPlayer starts, starting from next to a corner square (cell 1) appears to be a bad move. |
| 4 | This configuration is the **base case** from which minor adjustments are made to see if the algorithm is improved.  Algorithm: mini-max with  alpha-beta pruning  Initial depth = 3  Followed by iterative deepening in range: 4 to 9 in steps of size 1.  Opening 1st and 2nd move:  **move 1: CustomPlayer (cell 5);** move 2: Opponent (random) | 53 (100 games) | If CustomPlayer starts, starting from next to a corner square (cell 5) appears to be a good move. |
| 5 | Algorithm: mini-max with  alpha-beta pruning  Initial depth = 3  Followed by iterative deepening in range: 4 to 9 in steps of size 1.  Opening 1st and 2nd move:  **move 1: CustomPlayer (cell 57);** move 2: Opponent (random) | 48 (100 games) | If CustomPlayer starts, starting from the middle of the board (cell 57) appears to be a neutral move. |
| 6 | Algorithm: mini-max with  alpha-beta pruning  Initial depth = 3  Followed by iterative deepening in range: 4 to 9 in steps of size 1.  Opening 1st and 2nd move:  move 1: Opponent (random); **move 2: Custom Player (map 1)**  Map 1 configuration and strategy is defined in the Para 3. Opening Move Strategy. | 31 (100 games) | If Opponent starts, Map 1 is a bad configuration to for CustomPlayer next move. |
| 7 | Algorithm: mini-max with  alpha-beta pruning  Initial depth = 3  Followed by iterative deepening in range: 4 to 9 in steps of size 1.  Opening 1st and 2nd move:  move 1: Opponent (random); **move 2: Custom Player (map 2)**  Map 2 configuration and strategy is defined in the Para 3. Opening Move Strategy. | 53 (100 games) | If Opponent starts, Map 2 is a bad configuration to for CustomPlayer next move. |
| 8 | Algorithm: mini-max with  alpha-beta pruning  Initial depth = 3  Followed by iterative deepening in range: 4 to 9 in steps of size 1.  Opening 1st and 2nd move:  move 1: Opponent (random); **move 2: Custom Player (map 3)**  Map 3 configuration and strategy is defined in the Para 3. Opening Move Strategy. | 48 (100 games) | If Opponent starts, Map 3 is a neutral configuration to for CustomPlayer next move. |
| 9 | Algorithm: mini-max with  alpha-beta pruning  Initial depth = 3  Followed by iterative deepening in range: 4 to 9 in steps of size 1.  Opening 1st and 2nd move:  move 1: Opponent (random); **move 2: Custom Player (map 4)**  Map 4 configuration and strategy is defined in the Para 3. Opening Move Strategy. | 47 (100 games) | If Opponent starts, Map 2 is a neutral configuration to for CustomPlayer next move. |
| 10 | This configuration is a mixture of the most successful configurations from 1 to 9 above.  Algorithm: mini-max with  alpha-beta pruning  Initial depth = 3  Followed by iterative deepening in range: 4 to 9 in steps of size 1.  Opening 1st and 2nd move:  move 1: Opponent (random); **move 2: Custom Player (map 2)**  Opening 1st and 2nd move:  **move 1: CustomPlayer (cell 5);** move 2: Opponent (random) | 52.8 (400 games) |  |

**Discussion and Further work:**

Iterative deepening did not appear to have a significant impact in improving the chance of winning.

Correctly identifying the best heuristic is complicated by the fact that the number of simulations to be carried out is high in order to make the results statistically significant. Further, the background processes in the PC used for carrying out the simulation can have an impact on the simulation runs and results. This adds noise to the selection process of the best heuristic.

If CustomPlayer moves first, a good move is cell (5) or similar. That is, a cell that is located in the middle of one of the board edges.

If the Opponent moves first, CustomPlayer first move should be on an opposite colour tile as close as possible to the Opponent, using the board edges if available.

**Opening move Strategy:**

When the Opponent 1st move is any of the cells below. The move by CustomPlayer is followed by the strategies 1 to 4 below:



**Map 1 Strategy:**

* Make CustomPlayer first move on the same colour tile as Opponent.
* As close as possible to opponent move.
* Avoid edges of the board.
* Move towards the center of the board.



**Map 2 Strategy:**

* Make CustomPlayer first move on the opposite colour tile as Opponent.
* As close as possible to opponent move.
* Use edges of the board if possible.



**Map 3 Strategy:**

* Make CustomPlayer first move on the same colour tile as Opponent.
* As far as possible to opponent move.
* Symmetrical move if possible."



**Map 4 Strategy:**

* Make CustomPlayer first move on the opposite colour tile as Opponent.
* As far as possible to opponent move.
* Symmetrical move if possible."

