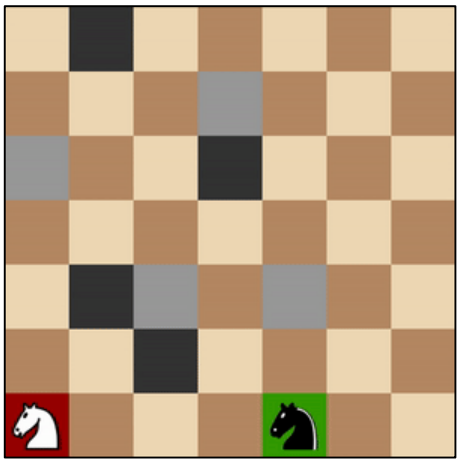
HEURISTIC ANALYSIS

ISOLATION: GAME PLAYING AGENT

During the development of the game playing agent, four different heuristics were implemented. This analysis describes the result of the study whose aim was to evaluate the performance of each of the implemented heuristics against the heuristic taught in class – the difference between the legal moves of player vs. the opponent. This heuristic is referred to as 'ID_Improved' throughout this analysis, where 'ID' stands for 'iterative deepening'.

HEURISTICS IMPLEMENTED

- **Heuristic 1 – Penalizing Corners:** The first heuristic (**`penalize_corners`**) elaborates the idea of 'ID_Improved' by penalizing the player when the current state of the board includes locations in corners. This is done because corners decrease the number of available moves which further spoils the change of winning the game as player can easily be 'trapped' in a corner). This can be noted in the image below.



The penalty weight is set to *four*, the performance of the function might change if this value is set to something different.

ID_Improved Evaluation		Result	Student Evaluation		Result
ID_Improved	Random	16 to 04	Student	Random	16 to 04
ID_Improved	MM_Null	15 to 05	Student	MM_Null	14 to 06
ID_Improved	MM_Open	13 to 05	Student	MM_Open	15 to 05
ID_Improved	MM_Improved	09 to 11	Student	MM_Improved	16 to 04
ID_Improved	AB_Null	17 to 03	Student	AB_Null	12 to 08
ID_Improved	AB_Open	11 to 09	Student	AB_Open	13 to 07
ID_Improved	AB_Improved	16 to 04	Student	AB_Improved	15 to 05
ID_Improved		**69.29%**	**Student**		**72.14%**

Table 1: 'ID_Improved' vs. 'penalize_corners'

- **Heuristic 2 – Distancing Player from Opponent:** The second heuristic (**`far_away`**) also elaborates on the idea of 'ID_Improved'. It credits the player moves which are farther away from its opponent. This is done by adding the distance measure between player and opponent to the number of legal moves of the player. Therefore, a player which moves a greater distance from the opponent will have a higher score.

  This heuristic does not affect the game agent much. This could be because of the nature of the players which move like knights. Distance measure would have made more sense in case of queen/rook like movements.

ID_Improved Evaluation		Result	Student Evaluation		Result
ID_Improved	Random	14 to 06	Student	Random	15 to 05
ID_Improved	MM_Null	14 to 06	Student	MM_Null	17 to 03
ID_Improved	MM_Open	12 to 08	Student	MM_Open	10 to 10
ID_Improved	MM_Improved	13 to 07	Student	MM_Improved	12 to 08
ID_Improved	AB_Null	18 to 02	Student	AB_Null	13 to 07
ID_Improved	AB_Open	12 to 08	Student	AB_Open	14 to 06
ID_Improved	AB_Improved	11 to 09	Student	AB_Improved	13 to 07
ID_Improved		**67.14%**	**Student**		**67.14%**

Table 2: 'ID_Improved' vs. 'far_away'

- **Heuristic 3 – Foresee Better Moves:** The third heuristic (**`forsee_moves`**) is an extension of 'ID_Improved' as well. In addition to calculating the difference between the legal moves of player and the opponent, 'forsee_moves' calculates how many moves does each of those next legal moves have. Ultimately, it supports legal moves which have a larger number of moves in the future. Intuitively, this happens to be the best heuristic.

ID_Improved Evaluation		Result	Student Evaluation		Result
ID_Improved	Random	14 to 06	Student	Random	17 to 03
ID_Improved	MM_Null	18 to 02	Student	MM_Null	17 to 03
ID_Improved	MM_Open	13 to 07	Student	MM_Open	14 to 06
ID_Improved	MM_Improved	11 to 09	Student	MM_Improved	15 to 05
ID_Improved	AB_Null	14 to 05	Student	AB_Null	14 to 06
ID_Improved	AB_Open	10 to 10	Student	AB_Open	15 to 05
ID_Improved	AB_Improved	10 to 10	Student	AB_Improved	16 to 04
ID_Improved		**64.29%**	**Student**		**77.14%**

Table 3: 'ID_Improved' vs. 'foresee_moves'

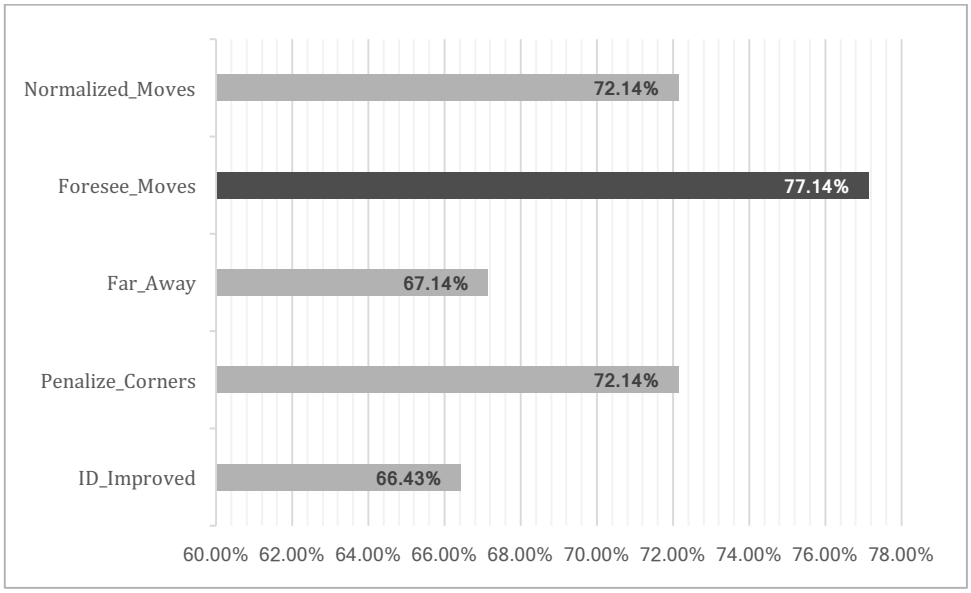
- **Heuristic 4 – Normalized Moves:** The fourth heuristic (**`nomarlized_moves`**) is a heuristic that returns the difference of player's and opponent's move(s), divided by total of all remaining legal moves**.** This has not direct intuitive sense to how a human might approach gameplay, yet a normalized score could affect move-making for a game-agent.

▪ ID_Improved Evaluation		Result	Student Evaluation		Result
ID_Improved	Random	14 to 06	Student	Random	17 to 03
ID_Improved	MM_Null	14 to 06	Student	MM_Null	16 to 04
ID_Improved	MM_Open	12 to 08	Student	MM_Open	15 to 05
ID_Improved	MM_Improved	13 to 07	Student	MM_Improved	11 to 09
ID_Improved	AB_Null	17 to 03	Student	AB_Null	16 to 04
ID_Improved	AB_Open	10 to 10	Student	AB_Open	12 to 08
ID_Improved	AB_Improved	11 to 09	Student	AB_Improved	10 to 10
ID_Improved		**65.00%**	**Student**		**72.14%**

Table 3: 'ID_Improved' vs. 'normalized_moves'

HEURISTICS COMPARISON

For visualization, an average of the performance of 'ID_Improved' has been taken.



As from the experiment conducted, it can be noted that intuitively best heuristic also performs the best experimentally. The possible reasons for this are:

i. It extends 'ID_Improved', which is already a decent heuristic.
ii. It does not affect the ability of the algorithm to search deep in the game tree.
iii. "It calculates how many moves does each of those next legal moves have. Ultimately, it supports legal moves which have a larger number of moves in the future." – This **builds up on the whole idea of the game of isolation**, hence, it's performance also supports the intuition.