Heuristic Analysis for isolation Game play

Comparison of Heuristics used:

Heuristic	ID_Improved	Student
move_to_opponent	69.29%	60.71%
move_towards_center	67.14%	61.43%
Difference between number of legal moves; Penalty for moves with Corner positions based on game state	65.00%	63.57%
Difference between number of legal moves; Penalty for moves with Corner positions based on game state; Reward for moves with center positions based on game state (submitted)	67.86%	**70.00%**

Heuristic 1:

move_to_opponent

Calculated the difference in the co-ordinates of the player and the opponent (squared) as a heuristic to determine the distance between their positions.

Larger distances are penalized so that the player closely follows the opponent.

Pros:

- Easy to implement

Cons:

- Does not take the game state (how many blocks are empty etc) into consideration as an additional factor for penalty/Reward

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 Evaluating: ID_Improved

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Playing Matches:

  Match 1: ID_Improved vs   Random   Result: 17 to 3
  Match 2: ID_Improved vs   MM_Null   Result: 15 to 5
  Match 3: ID_Improved vs   MM_Open   Result: 14 to 6
  Match 4: ID_Improved vs MM_Improved   Result: 12 to 8
  Match 5: ID_Improved vs   AB_Null   Result: 16 to 4
  Match 6: ID_Improved vs   AB_Open   Result: 12 to 8
  Match 7: ID_Improved vs AB_Improved   Result: 11 to 9

Results:

ID_Improved   69.29%

****
  Evaluating: Student
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Playing Matches:

  Match 1: Student vs Random   Result: 15 to 5
  Match 2: Student vs MM_Null   Result: 15 to 5
  Match 3: Student vs MM_Open   Result: 14 to 6
  Match 4: Student vs MM_Improved   Result: 8 to 12
  Match 5: Student vs AB_Null   Result: 13 to 7
  Match 6: Student vs AB_Open   Result: 11 to 9
  Match 7: Student vs AB_Improved   Result: 9 to 11

  Results:

  Student   60.71%

Heuristic 2:

move_towards_center

Center positions provide better mobility for the player as the game progresses Calculated 4 center positions
Eg: for a 4 x 4 board below, there are 4 center positions as below"

	Center	Center	
	Center	Center	

If a legal move has one of the center positions, reward the maximizing player and penalize for legal moves of the opponent with center positions.

Pros:

- Better performance than Heuristic 1 (Following the opponent) and takes the player closer to the center of the board from where higher number of moves are possible.
- Board partitioning can be delayed by picking moves with center positions.

Cons:

- Does not take the game state (how many blocks are empty etc) into consideration as an additional factor for penalty/Reward

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 Evaluating: ID_Improved
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Playing Matches:
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  Match 1: ID_Improved vs   Random        Result: 14 to 6
  Match 2: ID_Improved vs   MM_Null       Result: 14 to 6
  Match 3: ID_Improved vs   MM_Open       Result: 13 to 7
  Match 4: ID_Improved vs MM_Improved     Result: 14 to 6
  Match 5: ID_Improved vs   AB_Null       Result: 15 to 5
  Match 6: ID_Improved vs   AB_Open       Result: 11 to 9
  Match 7: ID_Improved vs AB_Improved     Result: 13 to 7


Results:
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ID_Improved   67.14%

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***********************
  Evaluating: Student
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Playing Matches:
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Match 1: Student vs Random   Result: 16 to 4
Match 2: Student vs MM_Null   Result: 11 to 9
Match 3: Student vs MM_Open   Result: 8 to 12
Match 4: Student vs MM_Improved   Result: 13 to 7
Match 5: Student vs AB_Null   Result: 14 to 6
Match 6: Student vs AB_Open   Result: 14 to 6
Match 7: Student vs AB_Improved   Result: 10 to 10

Results:

Student   61.43%

Heuristic 3:

board_usage_with_corner

As the game board usage values (number of positions on the board already traversed) increases as the game progresses, corner moves are more likely to lead to isolation after more than 75% (arbitrarily picked a high percentage) of the positions have already been traversed.

The penalty for legal corner moves is increased by a factor of 4 if the board usage exceeds 75 percent.

Pros:

- Takes the game state (number of positions still available on the board) into consideration.
- Penalty/reward is not static and varies according to the state of the board.
  Will push the player to pick center positions (by penalizing corner position) thereby providing more mobility in case of a partitioned board.
- Performance gain over Heuristic 1 (move closer to opponent), Heuristic 2 (Pick Center positions).

Cons:

- Additional computation/check required for the state of the board.

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 Evaluating: ID_Improved
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Playing Matches:

  Match 1: ID_Improved vs   Random   Result: 14 to 6
  Match 2: ID_Improved vs   MM_Null   Result: 17 to 3
  Match 3: ID_Improved vs   MM_Open   Result: 10 to 10
  Match 4: ID_Improved vs MM_Improved   Result: 11 to 9
  Match 5: ID_Improved vs   AB_Null   Result: 14 to 6
  Match 6: ID_Improved vs   AB_Open   Result: 11 to 9
  Match 7: ID_Improved vs AB_Improved   Result: 14 to 6

Results:

ID_Improved   65.00%

****
  Evaluating: Student
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Playing Matches:

  Match 1: Student vs Random   Result: 14 to 6
  Match 2: Student vs MM_Null   Result: 14 to 6
  Match 3: Student vs MM_Open   Result: 12 to 8
  Match 4: Student vs MM_Improved   Result: 11 to 9
  Match 5: Student vs AB_Null   Result: 13 to 7
  Match 6: Student vs AB_Open   Result: 15 to 5
  Match 7: Student vs AB_Improved   Result: 10 to 10

Results:

Student   63.57%

Heuristic 4 (submitted)

This is an amalgamation of Heuristic 4 and Heuristic 3 leading to improvement in performance and consistently beats '**ID_Improved'**

I used three factors here:

- Difference in the Number of legal moves available for the player and the opponent
- Calculated the game board usage and used it as a factor to penalize moves involving the corner positions of the board

- Used the center positions of the board to reward moves involving center positions as is shown in heuristic 2.

Pros:

- Takes the game state (number of positions still available on the board) into consideration.
- Penalty/reward is not static and varies according to the state of the board.
- Board partitioning can be delayed by rewarding moves with center positions and penalizing moves with corner positions.
- Beats the performance of all previous heuristics and also '**ID_Improved**' consistentlly

Cons:

- Additional computation/check required for the state of the board.

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 Evaluating: ID_Improved
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Playing Matches:

  Match 1: ID_Improved vs   Random   Result: 16 to 4
  Match 2: ID_Improved vs   MM_Null   Result: 13 to 7
  Match 3: ID_Improved vs   MM_Open   Result: 15 to 5
  Match 4: ID_Improved vs MM_Improved   Result: 13 to 7
  Match 5: ID_Improved vs   AB_Null   Result: 13 to 7
  Match 6: ID_Improved vs   AB_Open   Result: 11 to 9
  Match 7: ID_Improved vs AB_Improved   Result: 14 to 6

Results:

ID_Improved   67.86%

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  Evaluating: Student
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Playing Matches:

  Match 1: Student vs Random   Result: 16 to 4
  Match 2: Student vs MM_Null   Result: 17 to 3

Match 3: Student   vs   MM_Open   Result: 13 to 7
Match 4: Student   vs MM_Improved   Result: 13 to 7
Match 5: Student   vs   AB_Null   Result: 14 to 6
Match 6: Student   vs   AB_Open   Result: 12 to 8
Match 7: Student   vs AB_Improved   Result: 13 to 7

Results:

Student   70.00%