heuristic+analysis

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1 Heuristic Analysis

A game playing agent for playing 7x7 Isolation was created. Evaluation functions were created and compared to determine the efficacy of various heuristics. These heuristics, along with an iterative deepening agent for control, were compared with 7 different agents which utilized random moves, a minmax algorithm or alpha-beta pruning. Heuristic 1 utilizes the agent suggested in lecture that subtracts twice as many opponent moves for every player move. This heuristic was superior to the Improved agent but not by a large margin.

Opponent	Improved_ID 1	Heuristic 1
Random	15	15
MM_Null	14	15
MM_Open	11	10
MM_Improved	11	12
AB_Null	14	14
AB_Open	13	14
AB_Improved	11	13
	63.57%	66.43%

```
In [1]: import numpy as np
        from matplotlib import pyplot as plt

        n_groups = 7
        id_improved1, heuristic1 = np.loadtxt('heuristic1.txt', delimiter = ',', unpack = True)

        # Get current size
        fig_size = plt.rcParams["figure.figsize"]

        # Set figure width to 12 and height to 9
        fig_size[0] = 12
        fig_size[1] = 9
        plt.rcParams["figure.figsize"] = fig_size

        fig, ax = plt.subplots()
        index = np.arange(n_groups)
        bar_width = 0.35
```
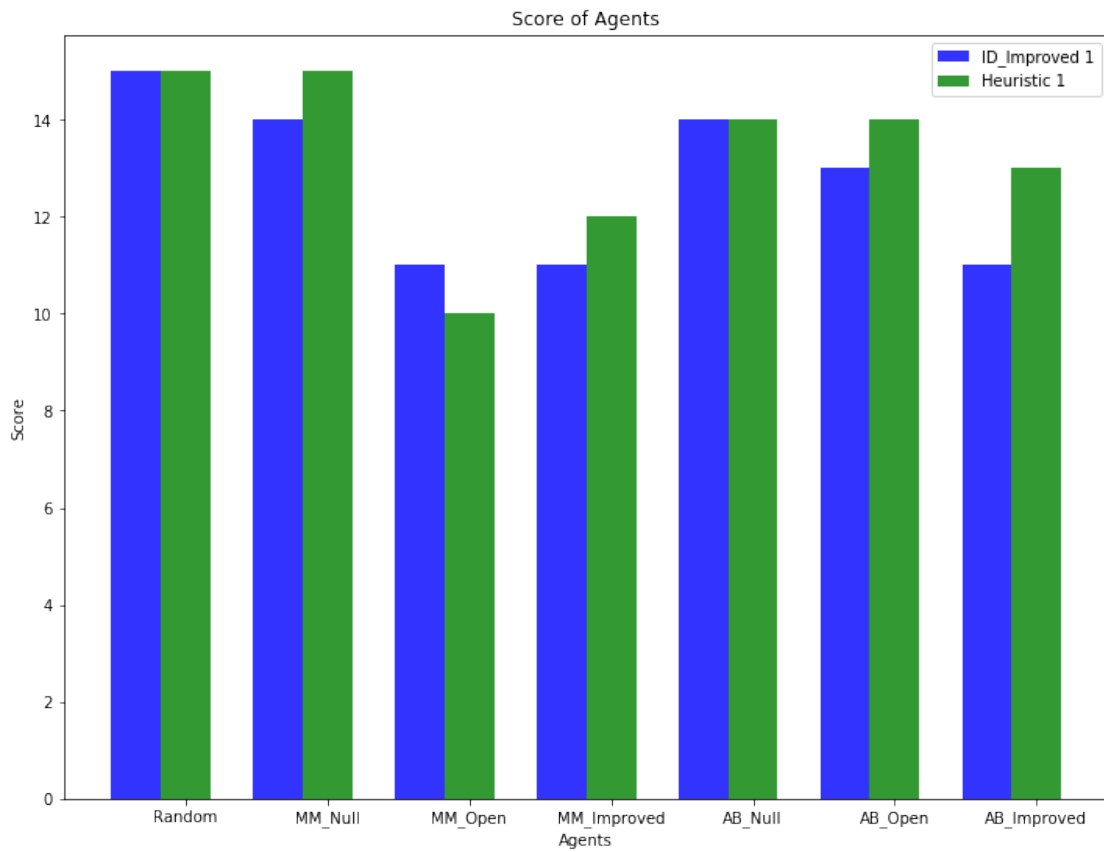
```
opacity = 0.8

rects1 = plt.bar(index, id_improved1, bar_width, alpha = opacity, color = 'b', label =

rects2 = plt.bar(index + bar_width, heuristic1, bar_width, alpha = opacity, color = 'g

plt.xlabel('Agents')
plt.ylabel('Score')
plt.title('Score of Agents')
plt.xticks(index + bar_width, ('Random', 'MM_Null', 'MM_Open', 'MM_Improved', 'AB_Null
plt.legend()

ax.set_xticks(ax.get_xticks())
plt.show()
```


Heuristic 2 used an evaluation function that focused on control of the center of the board. Each player location was recorded and a higher score was returned for whichever player was closer to the center. This heuristic much worse than the Improved_ID agent. It is difficult to ascertain much without more data points but this trial suggests heuristic 2 is not more effective than the first heuristic.

Opponent	Improved_ID 2	Heuristic 2
Random	17	17
MM_Null	18	11
MM_Open	15	12
MM_Improved	14	10
AB_Null	13	14
AB_Open	12	14
AB_Improved	8	13
	69.29%	65.00%

```
In [2]: id_improved2, heuristic2 = np.loadtxt('heuristic2.txt', delimiter = ',', unpack = True)

        rects1 = plt.bar(index, id_improved2, bar_width, alpha = opacity, color = 'b', label =

        rects2 = plt.bar(index + bar_width, heuristic2, bar_width, alpha = opacity, color = 'g

        plt.xlabel('Agents')
        plt.ylabel('Score')
        plt.title('Score of Agents')
        plt.xticks(index + bar_width, ('Random', 'MM_Null', 'MM_Open', 'MM_Improved', 'AB_Null
        plt.legend()

        plt.show()
```
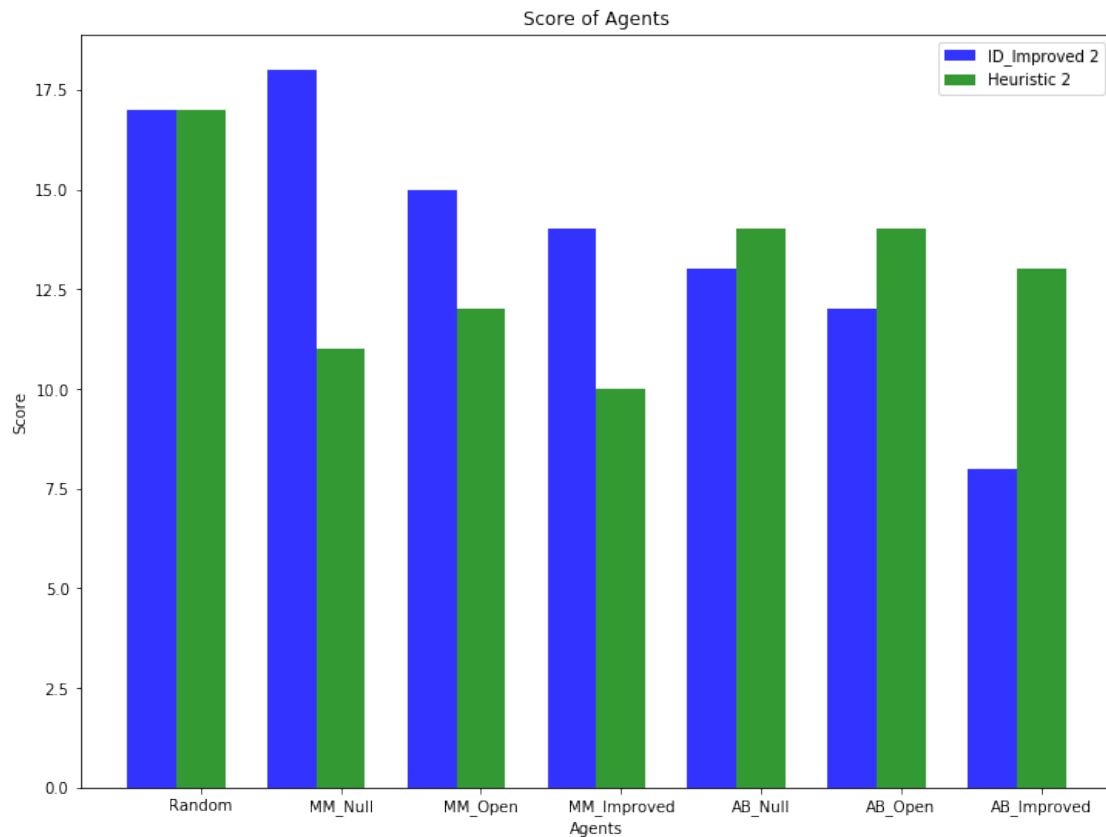
Heuristic 3 utilized an evaluation function that compared the difference in player and opponent moves as well as distance from center. Heuristic 3 exhibited the best score of the three heuristics. While Heuristic 2 performed worse than 1, the combination of 1 and 2 was superior to either. A possible explanation is that the combination of two different heuristics into one function is superior to using either alone.

| Opponent	Improved_ID 3	Heuristic 3
Random	18	17
MM_Null	14	16
MM_Open	11	17
MM_Improved	15	11
AB_Null	13	16
AB_Open	11	11
AB_Improved	12	12
	67.14%	71.43%

```
In [3]: id_improved3, heuristic3= np.loadtxt('heuristic3.txt', delimiter = ',', unpack = True)

        rects1 = plt.bar(index, id_improved3, bar_width, alpha = opacity, color = 'b', label =

        rects2 = plt.bar(index + bar_width, heuristic3, bar_width, alpha = opacity, color = 'g

        plt.xlabel('Agents')
        plt.ylabel('Score')
        plt.title('Score of Agents')
        plt.xticks(index + bar_width, ('Random', 'MM_Null', 'MM_Open', 'MM_Improved', 'AB_Null
        plt.legend()

        plt.show()
```

Score of Agents
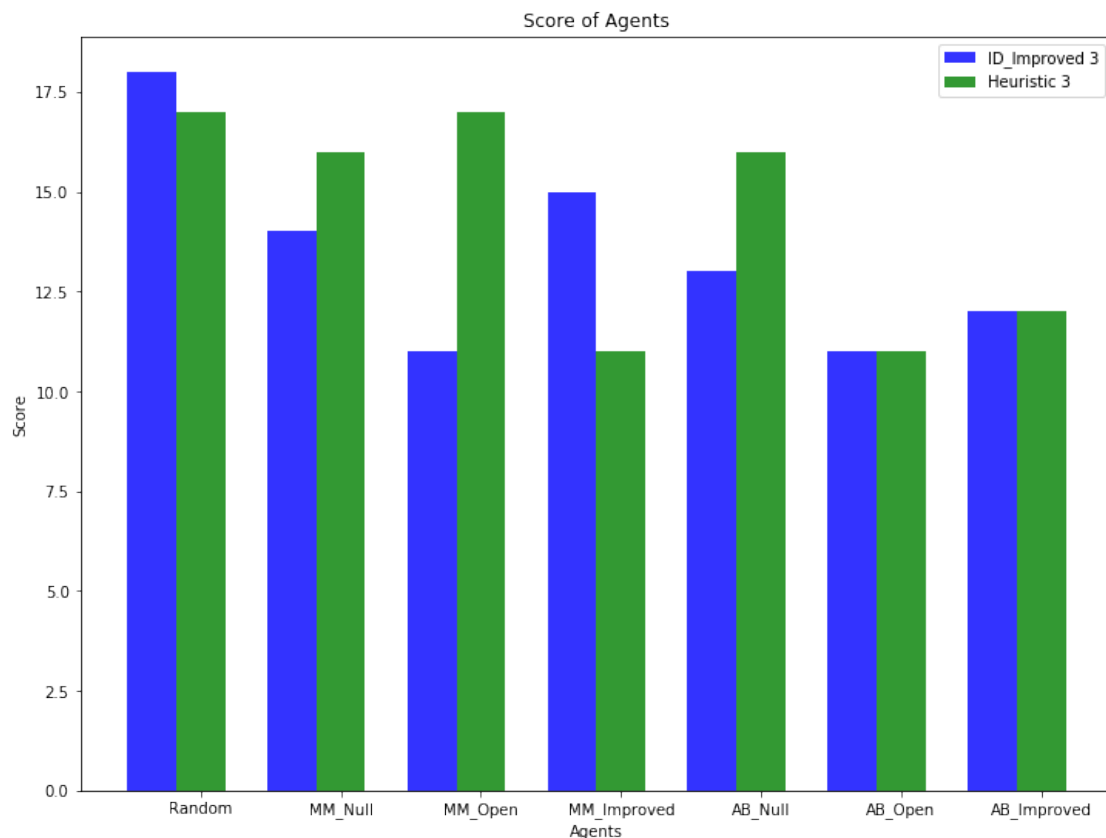
2 Conclusion

Heuristic 3 seems to be the most effective heuristic. However, many more trials should be performed to demonstrate its' superiority. The variation in the scores of the ID_Improved Agent demonstrates how much difference can exist even when running on the same hardware.

Heuristic 3 is chosen for several reasons. Heuristic 3 had both the absolute and relatively best performance compared with the ID agent. Heuristic 3 could also be improved by weighing the various factors with specific weights. It can be made to weigh opponent moves more heavily like Heuristic 1 or the reverse scenario where distance to center is more heavily weighted. This could potentially further improve the heuristic without adding excessively complexity. Heuristic 3 is also chosen because it does not require forecasting available moves after making a move which would potentially require many more computations.