report

September 23, 2018

1 Adversarial Agent

- I experimented with
  - Iterative deepening.
  - Alphabeta algorithm.
  - Heuristic: rewarding more to -
    - restrict apponents future liberties.
    - stay closer to the center of the board.

1.1 Winning-rate comparison: base and custom algorithm

```
In [1]: import pandas as pd
        import matplotlib.pyplot as plt
        import os
        os.environ['PATH']
```

```
Out[1]: '/home/lab/anaconda3/envs/aind/bin:/home/lab/anaconda3/envs/aind/bin:/home/lab/anaconda
```

```
In [2]: cols = ['algorithm', 'opponent' ]
        df = pd.read_table("./reportsfull/game_result.csv", sep="," )
        df['name'] = df[cols].apply(lambda row: '_'.join(row.values.astype(str)), axis=1)
        df
```

Out[2]:

	algorithm	opponent	rounds	time	percentageWin	name
0	custom	RANDOM	100	75	96.0	custom_RANDOM
1	custom	GREEDY	100	75	99.0	custom_GREEDY
2	custom	MINIMAX	100	75	85.5	custom_MINIMAX
3	custom	SELF	100	75	49.5	custom_SELF
4	custom	RANDOM	100	150	97.0	custom_RANDOM
5	custom	GREEDY	100	150	99.5	custom_GREEDY
6	custom	MINIMAX	100	150	80.0	custom_MINIMAX
7	custom	SELF	100	150	50.0	custom_SELF
8	custom	RANDOM	100	750	96.5	custom_RANDOM
9	custom	GREEDY	100	750	100.0	custom_GREEDY
10	custom	MINIMAX	100	750	81.5	custom_MINIMAX
11	custom	SELF	100	750	50.0	custom_SELF
12	base	RANDOM	100	150	92.5	base_RANDOM

```
13      base   GREEDY     100   150          35.0     base_GREEDY
14      base  MINIMAX     100   150          48.5    base_MINIMAX
15      base     SELF     100   150          54.0       base_SELF
16      base   RANDOM     100   750          93.0     base_RANDOM
17      base   GREEDY     100   750          50.0     base_GREEDY
18      base  MINIMAX     100   750          50.0    base_MINIMAX
19      base     SELF     100   750          50.0       base_SELF
20      base   RANDOM     100    75          94.5     base_RANDOM
21      base   GREEDY     100    75          33.0     base_GREEDY
22      base  MINIMAX     100    75          47.0    base_MINIMAX
23      base     SELF     100    75          48.0       base_SELF
```

```
In [3]: df.cc = pd.Categorical(df.opponent)
        df['opponent_code'] = df.cc.codes
        df.cc.categories
```

```
/home/lab/anaconda3/envs/aind/lib/python3.5/site-packages/ipykernel_launcher.py:1: UserWarning
  """Entry point for launching an IPython kernel.
```

```
Out[3]: Index(['GREEDY', 'MINIMAX', 'RANDOM', 'SELF'], dtype='object')
```

Win-rate comparison: base and custom algorithm

```
In [4]: cols = ['algorithm', 'opponent' ]
        df.pivot(index="name", columns="time", values="percentageWin")
```

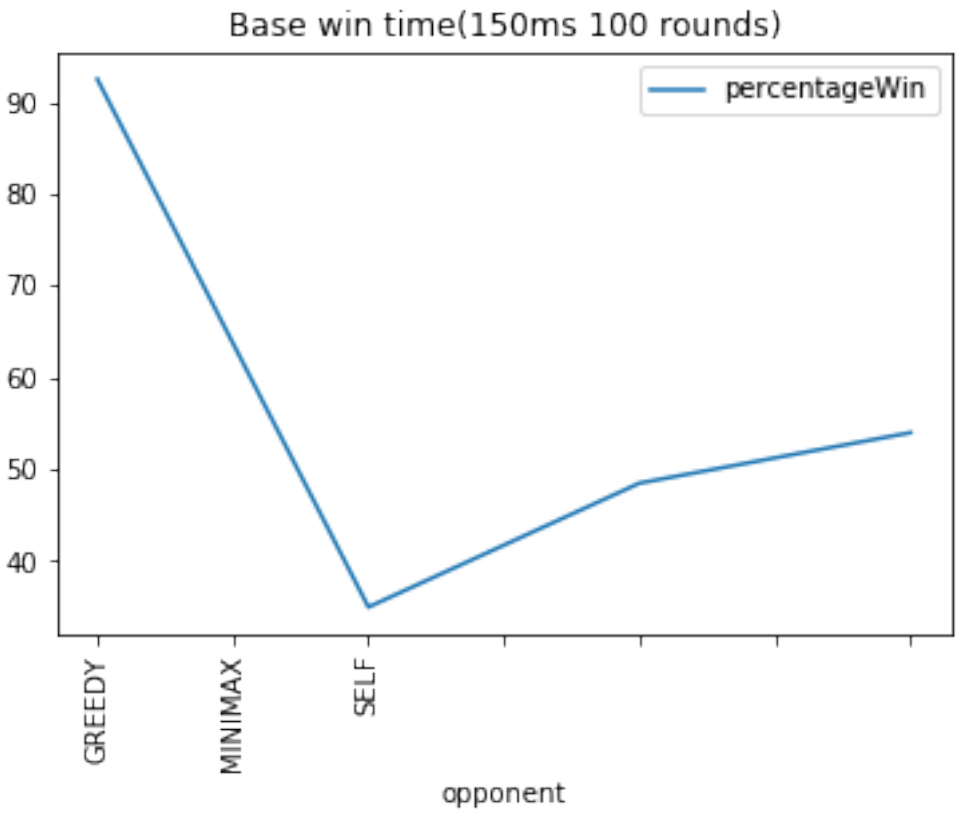
```
Out[4]: time             75    150    750
        name
        base_GREEDY     33.0  35.0   50.0
        base_MINIMAX    47.0  48.5   50.0
        base_RANDOM     94.5  92.5   93.0
        base_SELF       48.0  54.0   50.0
        custom_GREEDY   99.0  99.5  100.0
        custom_MINIMAX  85.5  80.0   81.5
        custom_RANDOM   96.0  97.0   96.5
        custom_SELF     49.5  50.0   50.0
```

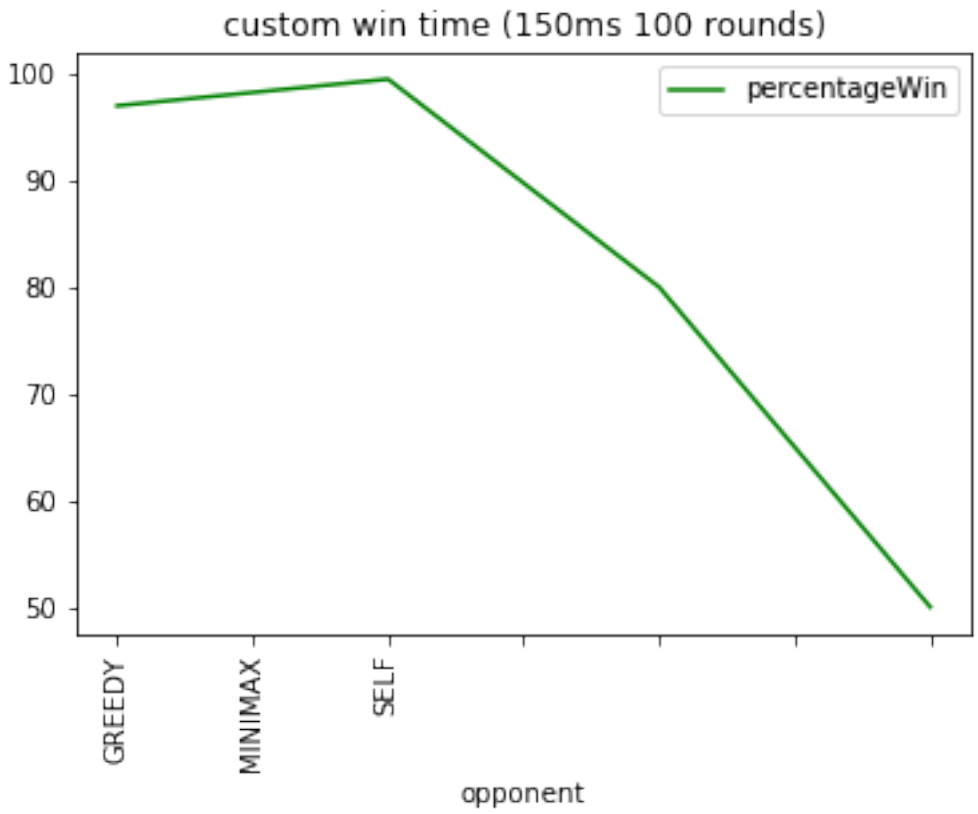
Win-rate comparison: base and custom algorithm

```
In [5]: df_g = df[(df.algorithm  ==  "base") & (df.time  == 150 )]
        ax =df_g.plot.line(y='percentageWin', x='opponent', title="Base win time(150ms 100 rou
        ax.set_xticklabels(df_g.opponent, rotation=90)

        df_g2 = df[(df.algorithm  ==  "custom") & (df.time  == 150 )]
        ax =df_g2.plot.line(y='percentageWin', x='opponent', title="custom win time (150ms 100
        ax.set_xticklabels(df_g2.opponent, rotation=90)
```

```
Out[5]: [Text(0,0,'RANDOM'), Text(0,0,'GREEDY'), Text(0,0,'MINIMAX'), Text(0,0,'SELF')]
```


Base win time(150ms 100 rounds)
percentageWin
90
80
70
60
50
40
GREEDY
MINIMAX
SELF
opponent



Win-rate comparison: base and custom algorithm

```
In [6]: df.loc[df.opponent == "GREEDY",["time", "name", "percentageWin"]].sort_values(by="time
```

```
Out[6]:     time           name  percentageWin
        1     75  custom_GREEDY           99.0
        21    75    base_GREEDY           33.0
        5    150  custom_GREEDY           99.5
        13   150    base_GREEDY           35.0
        9    750  custom_GREEDY          100.0
        17   750    base_GREEDY           50.0
```

Win-rate comparison: GREEDY + percentageWin + time

```
In [7]: df.loc[df.opponent == "MINIMAX",["time", "name", "percentageWin"]].sort_values(by="time
```

```
Out[7]:     time            name  percentageWin
        2     75  custom_MINIMAX           85.5
        22    75    base_MINIMAX           47.0
        6    150  custom_MINIMAX           80.0
        14   150    base_MINIMAX           48.5
        10   750  custom_MINIMAX           81.5
        18   750    base_MINIMAX           50.0
```

Win-rate comparison: MINIMAX + percentageWin + time

```
In [8]: df.loc[df.opponent == "RANDOM",["time", "name", "percentageWin"]].sort_values(by="time"
```

```
Out[8]:     time           name  percentageWin
        0     75  custom_RANDOM           96.0
        20    75    base_RANDOM           94.5
        4    150  custom_RANDOM           97.0
        12   150    base_RANDOM           92.5
        8    750  custom_RANDOM           96.5
        16   750    base_RANDOM           93.0
```

Win-rate comparison: RANDOM + percentageWin + time

```
In [9]: df.loc[df.opponent == "SELF",["time", "name", "percentageWin"]].sort_values(by="time")
```

```
Out[9]:     time         name  percentageWin
        3     75  custom_SELF           49.5
        23    75    base_SELF           48.0
        7    150  custom_SELF           50.0
        15   150    base_SELF           54.0
        11   750  custom_SELF           50.0
        19   750    base_SELF           50.0
```

Win-rate comparison: SELF + percentageWin + time

```
In [10]: df_g = df[(df.algorithm  ==  "custom") & (df.time  == 75 )]
         df_g
```

```
Out[10]:   algorithm opponent  rounds  time  percentageWin           name  \
         0    custom   RANDOM     100    75           96.0   custom_RANDOM
         1    custom   GREEDY     100    75           99.0   custom_GREEDY
         2    custom  MINIMAX     100    75           85.5  custom_MINIMAX
         3    custom     SELF     100    75           49.5     custom_SELF

            opponent_code
         0              2
         1              0
         2              1
         3              3
```

Win-rate comparison: custom + time = 75ms

```
In [11]: df_g = df[(df.algorithm  ==  "custom") & (df.time  == 150 )]
         df_g
```

```
Out[11]:   algorithm opponent  rounds  time  percentageWin           name  \
         4    custom   RANDOM     100   150           97.0   custom_RANDOM
         5    custom   GREEDY     100   150           99.5   custom_GREEDY
         6    custom  MINIMAX     100   150           80.0  custom_MINIMAX
```

```
7    custom     SELF     100   150           50.0     custom_SELF

   opponent_code
4              2
5              0
6              1
7              3
```

Win-rate comparison: custom + time = 150ms

```
In [12]: df_g = df[(df.algorithm  ==  "custom") & (df.time  == 750 )]
         df_g
```

```
Out[12]:    algorithm opponent  rounds  time  percentageWin            name  \
         8      custom   RANDOM     100   750           96.5   custom_RANDOM
         9      custom   GREEDY     100   750          100.0   custom_GREEDY
         10     custom  MINIMAX     100   750           81.5  custom_MINIMAX
         11     custom     SELF     100   750           50.0     custom_SELF

             opponent_code
         8               2
         9               0
         10              1
         11              3
```

Win-rate comparison: custom + time = 750ms

1.2 Search: as depth increases the wining rate also increases up to certain depth

```
In [13]: df = pd.read_table("./reportsD/depth_game_result.csv", sep="," )
         df
```

```
Out[13]:    algorithm apponent  rounds  time  depth  percentageWin
         0      custom  MINIMAX      10   150      3           30.0
         1      custom   GREEDY      10   150      3           50.0
         2      custom   RANDOM      10   150      3           90.0
         3      custom  MINIMAX      10   150      6           70.0
         4      custom   GREEDY      10   150      6          100.0
         5      custom   RANDOM      10   150      6          100.0
         6      custom  MINIMAX      10   150      9           80.0
         7      custom   GREEDY      10   150      9          100.0
         8      custom   RANDOM      10   150      9          100.0
         9      custom  MINIMAX      10   150     12           75.0
         10     custom   GREEDY      10   150     12          100.0
         11     custom   RANDOM      10   150     12          100.0
         12     custom  MINIMAX      10   150     15           90.0
         13     custom   GREEDY      10   150     15          100.0
         14     custom   RANDOM      10   150     15          100.0
```

Win-rate comparison: apponent + depth = [93,6,9,12,15]

```
In [14]: df_g = df[(df.apponent  ==  "MINIMAX")]
         df_g2= df_g[["apponent","depth","percentageWin"]]
         df_g2
```

```
Out[14]:    apponent  depth  percentageWin
         0   MINIMAX      3           30.0
         3   MINIMAX      6           70.0
         6   MINIMAX      9           80.0
         9   MINIMAX     12           75.0
         12  MINIMAX     15           90.0
```

Data for depth from 3 to 15

1.2.1 What features of the game does your heuristic incorporate, and why do you think those features matter in evaluating states during search?

Answer:

- I did use alpha-beta algorithm with iterative deepening. - Heuristic is based upon - Rewarding more if the moves results in :
  - 1: reducing opponents future possible moves. - 2: getting closer to the center of the board.
  - 3: consider the shared future moves (not used this in above tests)
- The results compared to the base heuristic seems to be improved.
- However, I think heuristic (1,2) could be weighted correctly to get better results. Specifically the min-max agent could still find better moves - in spite of increased time, depth.

1.2.2 Analyze the search depth your agent achieves using your custom heuristic. Does search speed matter more or less than accuracy to the performance of your heuristic?

Answer:

- The results above for depth testing: clearly shows depth has effect until some threshold.
- After that the better heuristic should be used for better results.
- Unlike greedy search, using depth the algorithm can see the wrong moves before hand.
- Increased time factor : does not have much effect after some threshold.
- Sure increased time and depth factors: has negative effect on the performance.
- The effect of time and depth on performance will become more severe when the complexity of problem increases. Only good heuristic could help in that case.