INFO 6205 Spring 2022 Project

Menace

Team

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- Introduction

  - Aim
  - Implement “The Menace” by replacing matchboxes with values in a hash set (key will be the state of the game).
  - Train the Menace by running games played against the “human” strategy, which is based upon optimal strategy (see Tic-tac-toe).
  - You will need to choose values for:
    - alpha (the number of” beads” to in each “matchbox” at the start of the game—maybe.
      different for each move: first move, second move, etc.)
    - beta (the number of” beads” to add to the “matchbox” in the event of a win).
    - gamma (the number of” beads” to take to the “matchbox” in the event of a loss).

- delta (the number of” beads” to add to the “matchbox” in the event of a draw).

- Approach

A web application developed with JavaScript, which supports 3 modes of play:

1. Human VS Menace
2. Menace VS Menace
3. Menace VS Perfect (Min-Max Approach)

Matchboxes are populated with a JavaScript Hash equivalent object array, each object holding the series of integers representing the beads. The Menace will be trained based on the outcome of every game and beads and moves will be reflected in the matchboxes. As the game progresses, Menace will be trained more to handle the game scenarios resulting in more Wins or Draws.

· Program

Data Structures & classes

- A hash set is used to store each board position
- Another Hash set is used to keep track of the moves and positions menace has encountered
- The board is represented as a 3 x 3 matrix which the index representing a cell position on the board

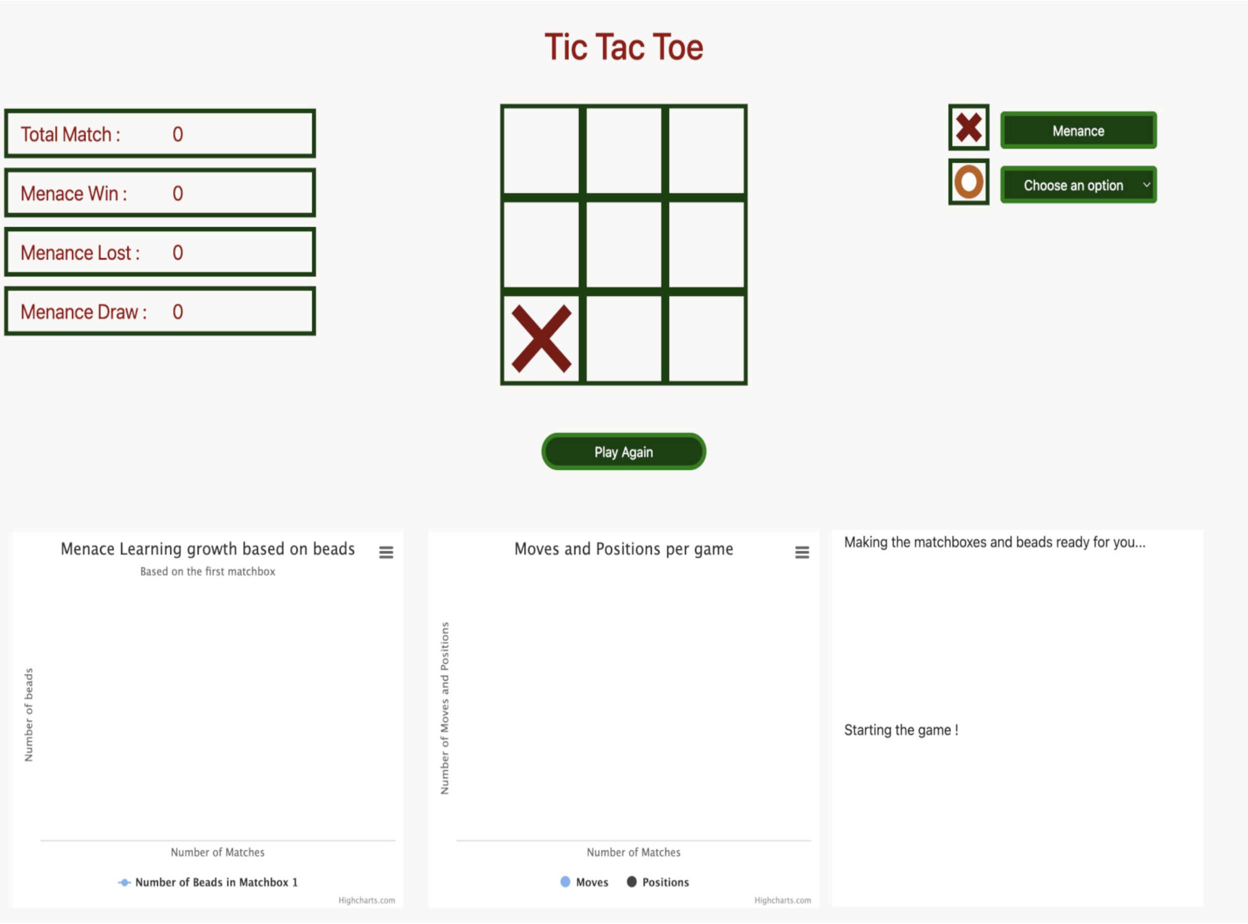
- Algorithm
  - A hash set was utilized to store each game's states and their corresponding moves.
  - Once MENACE encounters a certain move on the board it takes the current board state and compares it against the hash set.
  - The hash returns an array of moves.
  - One move is chosen at random from the list of moves
  - Simultaneously another hash set is used to keep track of the moves MENACE has chosen for the given board states

    - After the end of each game if MENACE wins the game, then a total of each of the board index of moves that menace used to win the game is repeated 3 times in the array
    - If MENACE loses the game, then the occurrence of that move order is removed from the hash set
    - If MENACE draws the game, then that board index is added one more time to that hash set

- Invariants
    - Menace relies on three major invariances for its functionality
    - ALPHA: The number of board indexes in each board position
    - BETA: The number board indexes to add in case of winning (+3)
    - GAMMA: The number board to remove after losing (-1)
    - DELTA: The number board indexes to add after the draw (+1)

Flow Charts (inc. UI Flow)

1. Tic Tac Toe Dashboard



Tic Tac Toe

Total Match : 0

Menace Win : 0

Menance Lost : 0

Menance Draw : 0

X Menance

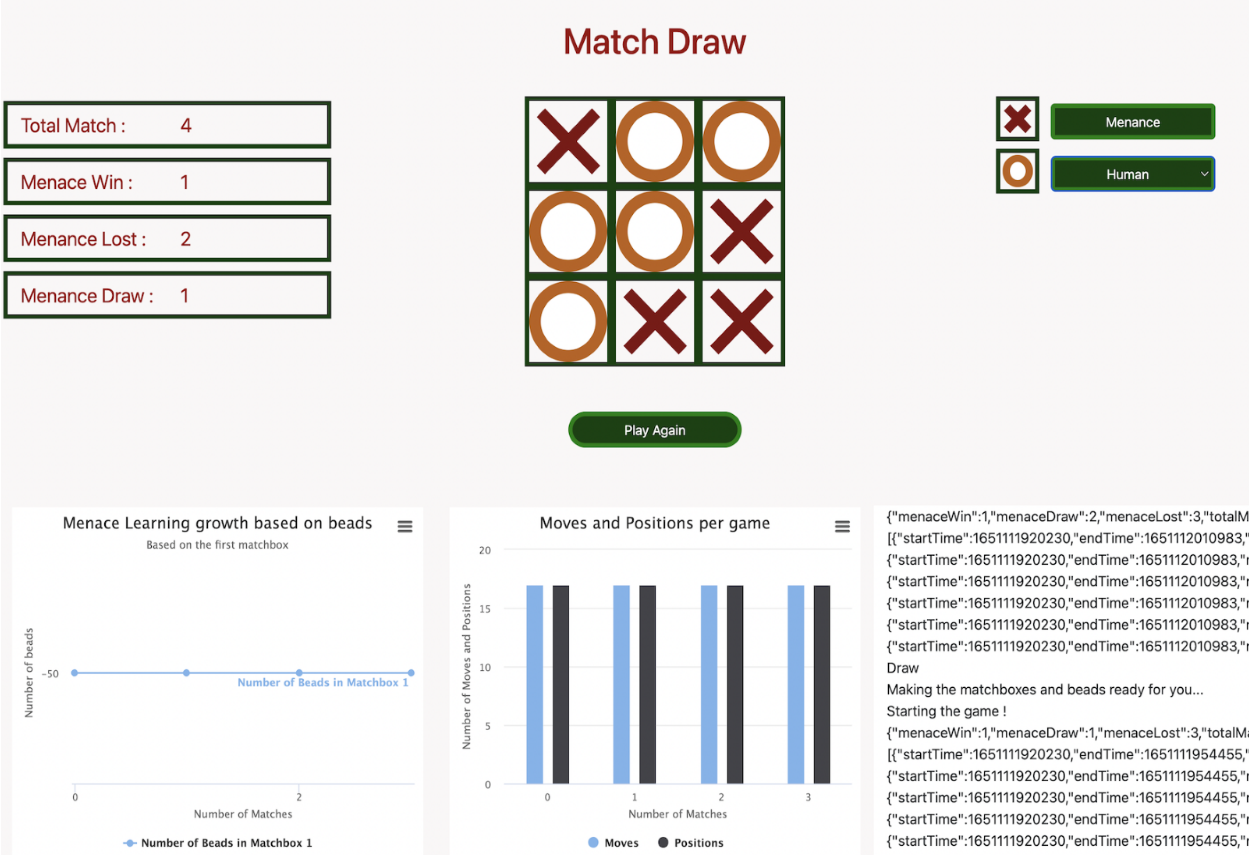
O Choose an option

Making the matchboxes and beads ready for you...

Starting the game !

Play Again
Menace Learning growth based on beads
Based on the first matchbox
Number of beads
Number of Matches
Number of Beads in Matchbox 1
Highcharts.com
Moves and Positions per game
Number of Moves and Positions
Number of Matches
Moves
Positions
Highcharts.com

2. Tic Tac Toe Dashboard - (Menance Vs Human)



Match Draw

Total Match : 4

Menace Win : 1

Menance Lost : 2

Menance Draw : 1

X	O	O
O	O	X
O	X	X

X Menance

O Human

Play Again
Menace Learning growth based on beads
Based on the first matchbox
Number of beads
-50
Number of Beads in Matchbox 1
0
2
Number of Matches
Number of Beads in Matchbox 1
Moves and Positions per game
Number of Moves and Positions
20
15
10
5
0
0
1
2
3
Number of Matches
Moves
Positions

```
{"menaceWin":1,"menaceDraw":2,"menaceLost":3,"totalM
[{"startTime":1651111920230,"endTime":1651112010983,"
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{"startTime":1651111920230,"endTime":1651112010983,"r
{"startTime":1651111920230,"endTime":1651112010983,"r
{"startTime":1651111920230,"endTime":1651112010983,"r
{"startTime":1651111920230,"endTime":1651112010983,"r
Draw
Making the matchboxes and beads ready for you...
Starting the game !
{"menaceWin":1,"menaceDraw":1,"menaceLost":3,"totalMa
[{"startTime":1651111920230,"endTime":1651111954455,"
{"startTime":1651111920230,"endTime":1651111954455,"r
{"startTime":1651111920230,"endTime":1651111954455,"r
{"startTime":1651111920230,"endTime":1651111954455,"r
{"startTime":1651111920230,"endTime":1651111954455,"r
```
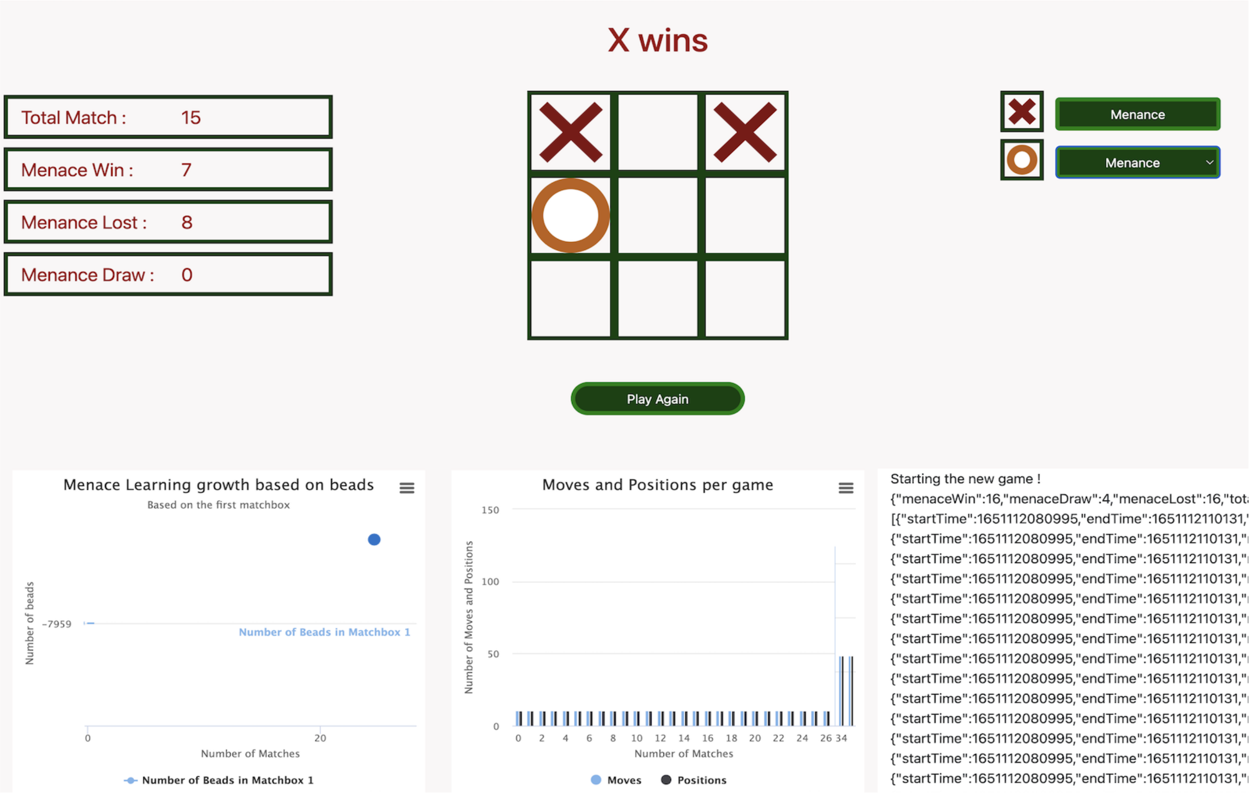

3. Tic Tac Toe Dashboard - (Menance Vs Menance)



X wins

Total Match : 15

Menace Win : 7

Menance Lost : 8

Menance Draw : 0

Menance
Menance
Play Again
Menace Learning growth based on beads
Based on the first matchbox
Number of beads
-7959
Number of Beads in Matchbox 1
0
20
Number of Matches
Number of Beads in Matchbox 1
Moves and Positions per game
Number of Moves and Positions
150
100
50
0
0
2
4
6
8
10
12
14
16
18
20
22
24
26
34
Number of Matches
Moves
Positions

```
Starting the new game !
{"menaceWin":16,"menaceDraw":4,"menaceLost":16,"tot
[{"startTime":1651112080995,"endTime":1651112110131,"
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{"startTime":1651112080995,"endTime":1651112110131,"
{"startTime":1651112080995,"endTime":1651112110131,"
{"startTime":1651112080995,"endTime":1651112110131,"
```
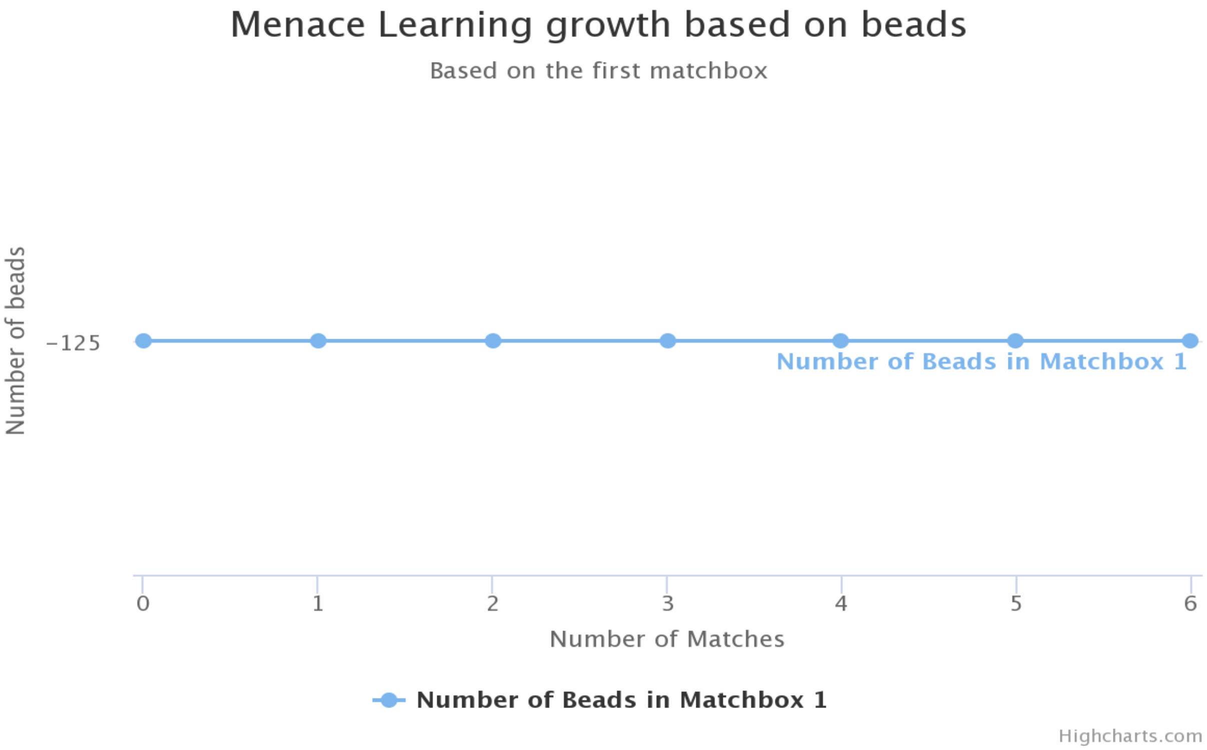
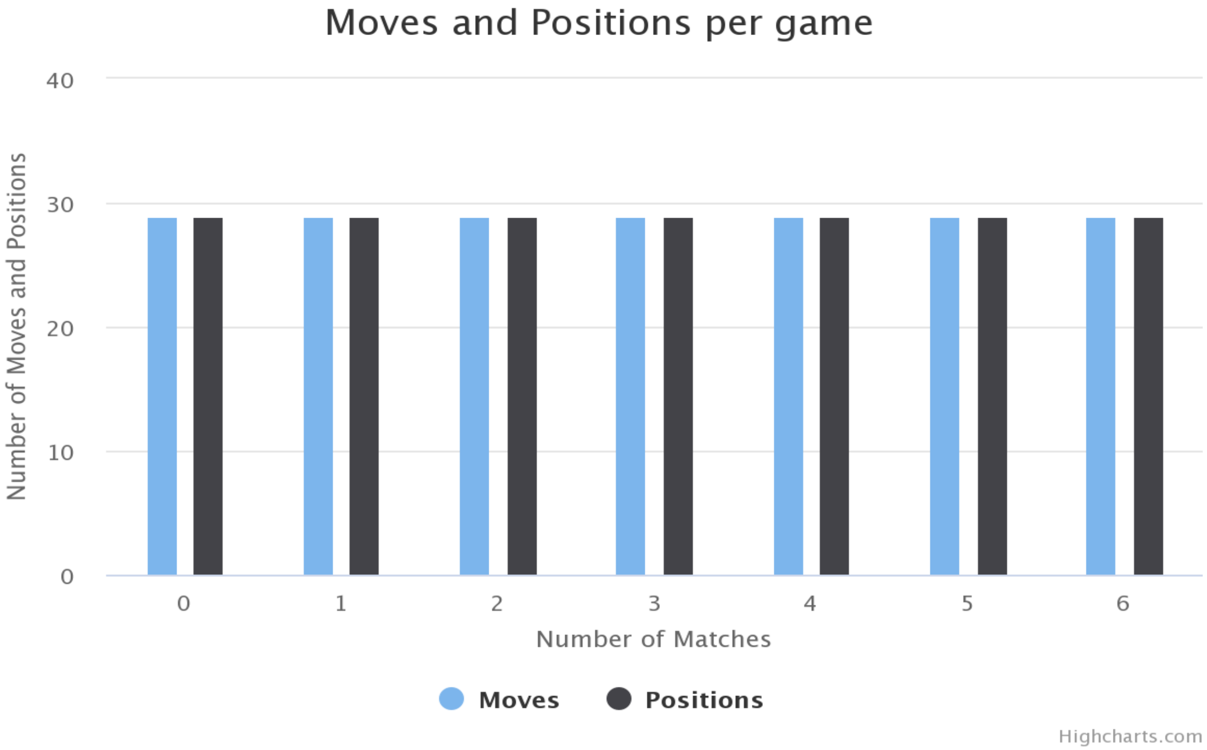

Observations & Graphical Analysis

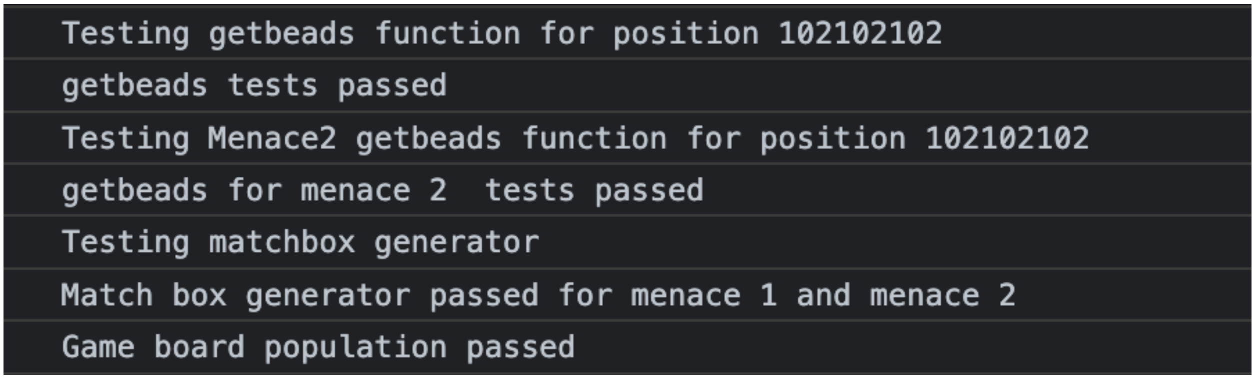

Menace Learning growth based on beads
Based on the first matchbox
Number of beads
−125
Number of Beads in Matchbox 1
0
1
2
3
4
5
6
Number of Matches
Number of Beads in Matchbox 1
Highcharts.com


Moves and Positions per game
40
30
20
10
0
Number of Moves and Positions
0
1
2
3
4
5
6
Number of Matches
Moves
Positions
Highcharts.com

Results & Mathematical Analysis

Against an opponent, after an initial couple of games MENACE has over a 70%-win rate. Against a human opponent following optimal strategy MENACE was able to draw the games more than 85% of the time. When two MENACE systems were pitted against each other, It was observed that one MENACE system was able to initially get the lead but after a couple of games, the other MENACE system was also able to catch up which resulted in drawn games.

Testcases



```
Testing getbeads function for position 102102102
getbeads tests passed
Testing Menace2 getbeads function for position 102102102
getbeads for menace 2  tests passed
Testing matchbox generator
Match box generator passed for menace 1 and menace 2
Game board population passed
```

Conclusion

After about 200 games the menace was able to steadily draw against an optimal opponent. MENACE was even able to win against opponents

When a sub-optimal strategy was used. This proves that menace was able to improve its strategy as an increased number of games were played.

References

1. https://www.mscroggs.co.uk/menace/
2. https://www.youtube.com/watch?v=azB1rUd-pIc
3. https://en.wikipedia.org/wiki/Tic-tac-toe