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CSc 215-01 Artificial Intelligence

Project #4

Mini-Project 4: Solving Tic-Tac-Toe and Wild Tic-Tac-Toe using Minimax Search

Due Date: 11/13/2019

Problem Statement

The goal of the project is to write minimax algorithm for both tic-tac-toe and wild tic-tac-toe games. Using the minimax algorithm the player picks an index that has the highest probability to win the game. In wild tic-tac-toe the user gets to pick either “x” or “o” in every chance

Methodology

We started the project by using the notebooks provided by the professor. Initially a player chooses its index by creating a tree until the child node and allocates the score to each index using minimax algorithm to choose the index that gives highest probability to win the game. We wrote the minimax algorithm to fulfill the task.

After writing the minimax algorithm, a) in the case of optimal vs optimal always the game ends up with a draw as both the players play optimally. b)In case of optimal vs you, we tried playing with the optimal player many times. While playing optimally the game becomes a draw and while playing randomly the optimal player was winning. We tried to win the game, but optimal player wasn’t giving that chance for us! In case of random vs optimal, most of the times the optimal player was winning, but there are few cases where the game ends up with a draw. The game in random vs optimal where it ends up with a draw can be seen below in Fig1.

In [13]:
```
random_vs_optimal()
```

```
Player x plays randomly, and Player o plays optimally.

Board :

  0  |  1  |  2  |
-----------------
  3  |  4  |  5  |
-----------------
  6  |  7  |  8  |
-----------------


x :

  0  |  1  |  2  |
-----------------
  3  |  4  |  x  |
-----------------
  6  |  7  |  8  |
-----------------


o :

  0  |  1  |  o  |
-----------------
  3  |  4  |  x  |
-----------------
  6  |  7  |  8  |
-----------------


x :

  0  |  x  |  o  |
-----------------
  3  |  4  |  x  |
-----------------
  6  |  7  |  8  |
-----------------


o :

  0  |  x  |  o  |
-----------------
  o  |  4  |  x  |
-----------------
  6  |  7  |  8  |
-----------------


x :

  0  |  x  |  o  |
-----------------
  o  |  4  |  x  |
-----------------
  x  |  7  |  8  |
-----------------


o :

  0  |  x  |  o  |
-----------------
  o  |  o  |  x  |
-----------------
  x  |  7  |  8  |
-----------------


x :

  x  |  x  |  o  |
-----------------
  o  |  o  |  x  |
-----------------
  x  |  7  |  8  |
-----------------


o :

  x  |  x  |  o  |
-----------------
  o  |  o  |  x  |
-----------------
  x  |  o  |  8  |
-----------------


x :

  x  |  x  |  o  |
-----------------
  o  |  o  |  x  |
-----------------
  x  |  o  |  x  |
-----------------

Draw!
```

Out[13]: 'Draw'

Fig1

Wild tic-tac-toe is different from tic-tac-toe. In wild tic-tac-toe we have 2 players and both players can choose a character either ‘x’ or ‘o’ to place on the board. In wild tic-tac-toe when we do with optimal Vs optimal we get two cases when the P1 uses the middle box it wins or else we get a draw condition. In the second case when we execute random Vs optimal , the optimal always wins. In you Vs optimal when both play optimal it case one else if we play randomly the optimal wins.

Experimental Results and Analysis:

Tic-tac-toe

Optimal Vs optimal

```
Player x and Player o Both play optimally.

Board :

  0  |  1  |  2  |
------------------
  3  |  4  |  5  |
------------------
  6  |  7  |  8  |
------------------

x :

  x  |  1  |  2  |
------------------
  3  |  4  |  5  |
------------------
  6  |  7  |  8  |
------------------

o :

  x  |  1  |  2  |
------------------
  3  |  o  |  5  |
------------------
```

```
  6  |  7  |  8  |
-----------------

x :

  x  |  x  |  2  |
-----------------
  3  |  o  |  5  |
-----------------
  6  |  7  |  8  |
-----------------

o :

  x  |  x  |  o  |
-----------------
  3  |  o  |  5  |
-----------------
  6  |  7  |  8  |
-----------------

x :

  x  |  x  |  o  |
-----------------
  3  |  o  |  5  |
-----------------
  x  |  7  |  8  |
-----------------

o :

  x  |  x  |  o  |
-----------------
  o  |  o  |  5  |
-----------------
  x  |  7  |  8  |
-----------------

x :

  x  |  x  |  o  |
-----------------
  o  |  o  |  x  |
```

```
------------------
  x  |  7  |  8  |
------------------

o :

  x  |  x  |  o  |
------------------
  o  |  o  |  x  |
------------------
  x  |  o  |  8  |
------------------

x :

  x  |  x  |  o  |
------------------
  o  |  o  |  x  |
------------------
  x  |  o  |  x  |
------------------

Draw!

'Draw'
```

Random Vs optimal

```
Player x plays randomly, and Player o plays optimally.

Board :

  0  |  1  |  2  |
------------------
  3  |  4  |  5  |
------------------
  6  |  7  |  8  |
------------------


x :

  x  |  1  |  2  |
------------------
  3  |  4  |  5  |
```

```
------------------
  6  |  7  |  8  |
------------------
```

o :

```
  x  |  1  |  2  |
------------------
  3  |  o  |  5  |
------------------
  6  |  7  |  8  |
------------------
```

x :

```
  x  |  1  |  x  |
------------------
  3  |  o  |  5  |
------------------
  6  |  7  |  8  |
------------------
```

o :

```
  x  |  o  |  x  |
------------------
  3  |  o  |  5  |
------------------
  6  |  7  |  8  |
------------------
```

x :

```
  x  |  o  |  x  |
------------------
  x  |  o  |  5  |
------------------
  6  |  7  |  8  |
------------------
```

```
o :

  x  |  o  |  x  |
-----------------
  x  |  o  |  5  |
-----------------
  6  |  o  |  8  |
-----------------

o Wins!

'o'
```

You Vs optimal

```
You play as Player x, can you win the game?

Board :

  0  |  1  |  2  |
-----------------
  3  |  4  |  5  |
-----------------
  6  |  7  |  8  |
-----------------

Please enter a valid cell (0, 1, 2, 3, 4, 5, 6, 7, 8): 5

x :

  0  |  1  |  2  |
-----------------
  3  |  4  |  x  |
-----------------
  6  |  7  |  8  |
-----------------

o :

  0  |  1  |  o  |
-----------------
  3  |  4  |  x  |
-----------------
  6  |  7  |  8  |
```

```
------------------

Please enter a valid cell (0, 1, 3, 4, 6, 7, 8): 4

x :

  0  |  1  |  o  |
------------------
  3  |  x  |  x  |
------------------
  6  |  7  |  8  |
------------------

o :

  0  |  1  |  o  |
------------------
  o  |  x  |  x  |
------------------
  6  |  7  |  8  |
------------------

Please enter a valid cell (0, 1, 6, 7, 8): 8

x :

  0  |  1  |  o  |
------------------
  o  |  x  |  x  |
------------------
  6  |  7  |  x  |
------------------

o :

  o  |  1  |  o  |
------------------
  o  |  x  |  x  |
------------------
  6  |  7  |  x  |
------------------

Please enter a valid cell (1, 6, 7): 7
```

```
x :

  o  |  1  |  o  |
------------------
  o  |  x  |  x  |
------------------
  6  |  x  |  x  |
------------------

o :

  o  |  o  |  o  |
------------------
  o  |  x  |  x  |
------------------
  6  |  x  |  x  |
------------------

o Wins!

'o'
```

Wild tic-tac toe

```
Player 1 and Player 2 Both play optimally.

Board :

  0  |  1  |  2  |
------------------
  3  |  4  |  5  |
------------------
  6  |  7  |  8  |
------------------

P1 :

  0  |  1  |  2  |
------------------
  3  |  x  |  5  |
------------------
  6  |  7  |  8  |
------------------


P2 :
```

```
  x  |  1  |  2  |
-----------------
  3  |  x  |  5  |
-----------------
  6  |  7  |  8  |
-----------------


P1 :

  x  |  1  |  2  |
-----------------
  3  |  x  |  5  |
-----------------
  6  |  7  |  x  |
-----------------

P1 Wins!

'P1'
```

Random Vs optimal

```
Player 1 plays randomly, and Player 2 plays optimally.

Board :

  0  |  1  |  2  |
-----------------
  3  |  4  |  5  |
-----------------
  6  |  7  |  8  |
-----------------


P1 :

  0  |  1  |  2  |
-----------------
  3  |  4  |  o  |
-----------------
  6  |  7  |  8  |
```

```
------------------


P2 :

  x  |  1  |  2  |
------------------
  3  |  4  |  o  |
------------------
  6  |  7  |  8  |
------------------


P1 :

  x  |  x  |  2  |
------------------
  3  |  4  |  o  |
------------------
  6  |  7  |  8  |
------------------


P2 :

  x  |  x  |  2  |
------------------
  x  |  4  |  o  |
------------------
  6  |  7  |  8  |
------------------


P1 :

  x  |  x  |  2  |
------------------
  x  |  4  |  o  |
------------------
  6  |  o  |  8  |
------------------


P2 :
```

```
  x  |  x  |  2  |
-----------------
  x  |  x  |  o  |
-----------------
  6  |  o  |  8  |
-----------------


P1 :

  x  |  x  |  2  |
-----------------
  x  |  x  |  o  |
-----------------
  o  |  o  |  8  |
-----------------


P2 :

  x  |  x  |  x  |
-----------------
  x  |  x  |  o  |
-----------------
  o  |  o  |  8  |
-----------------

P2 Wins!

'P2'
```

You Vs optimal

```
You play as Player 1

Board :

  0  |  1  |  2  |
-----------------
  3  |  4  |  5  |
-----------------
  6  |  7  |  8  |
-----------------
```

```
Please enter a valid cell (0, 1, 2, 3, 4, 5, 6, 7, 8): 4
Please enter a valid character (x, o): x

P1 :

  0  |  1  |  2  |
------------------
  3  |  x  |  5  |
------------------
  6  |  7  |  8  |
------------------

P2 :

  x  |  1  |  2  |
------------------
  3  |  x  |  5  |
------------------
  6  |  7  |  8  |
------------------

Please enter a valid cell (1, 2, 3, 5, 6, 7, 8): 8
Please enter a valid character (x, o): x

P1 :

  x  |  1  |  2  |
------------------
  3  |  x  |  5  |
------------------
  6  |  7  |  x  |
------------------

P1 Wins!

'P1'
```

Task Division and Project Reflection:

1.**Coming to task division**

Veena- part of tic-tac-toe, wild tic-tac-toe

Swetha – part of tic-tac-toe, documentation

Challenges:

1. In tic-tac-toe we have appended current with values first later realized we have to append with lists.
2. In wild tic-tac-toe we had difficulty how we have to give choice of x and o each turn initially

What we have learned from this project:

1. We learnt how to develop a game like tic-tac-toe and a modified wild tic-tac-toe
2. Problem solving ability.