Assignment 2 Artificial Intelligence

Project name : Using Minimax Algorithm to Make Connect 4 AI Agent

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Overview:

The provided code combines functionality for AI-based decision-making in board games using game-solving algorithms, decision tree construction, and board state evaluation. The code is modular, supporting multiple algorithms and providing tools for tree visualization.

Data structures used:

2D NumPy Array :

Represents board dimensions that consist of rows and columns it's used to store the board state which is to be (0) if the place is empty , (1) represents piece of player 1 and (2) represents piece of player 2 like self.current.state .

lists:

We did use list in our code to evaluate segment of board like row, column or diagonal to evaluate value of cells of board

And used to choose between different algorithms as Minimax and Minimax with pruning and Expected minimax

And its used to store prob. distribution

Tuples:

It holds direction of horizontal , vertical and diagonal to evaluate our windows that is used to find possible sequences for four pieces in row .

Sample runs:

Alpha beta pruning:

| 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| 0 | 0 | 0 | 0 | 0 | 0 | 0 |

Time Taken 0.0933985710144043

| 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| 0 | 0 | 0 | 2 | 0 | 0 | 0 |

| 0 | 0 | 0 | 1 | 0 | 0 | 0 |

Time Taken 0.1226944923400878 9

| 0 | 1 | 2 | 2 | 1 | 2 | 2 |

| 0 | 1 | 1 | 1 | 1 | 2 | 1 |

| 0 | 1 | 1 | 1 | 1 | 1 | 2 |

| 0 | 2 | 1 | 2 | 1 | 1 | 2 |

| 2 | 2 | 1 | 2 | 2 | 2 | 1 |

| 2 | 2 | 1 | 1 | 2 | 2 | 2 |

Taken 0.0009131431579589844

| 0 | 1 | 2 | 2 | 1 | 2 | 2 |

| 0 | 1 | 1 | 1 | 1 | 2 | 1 |

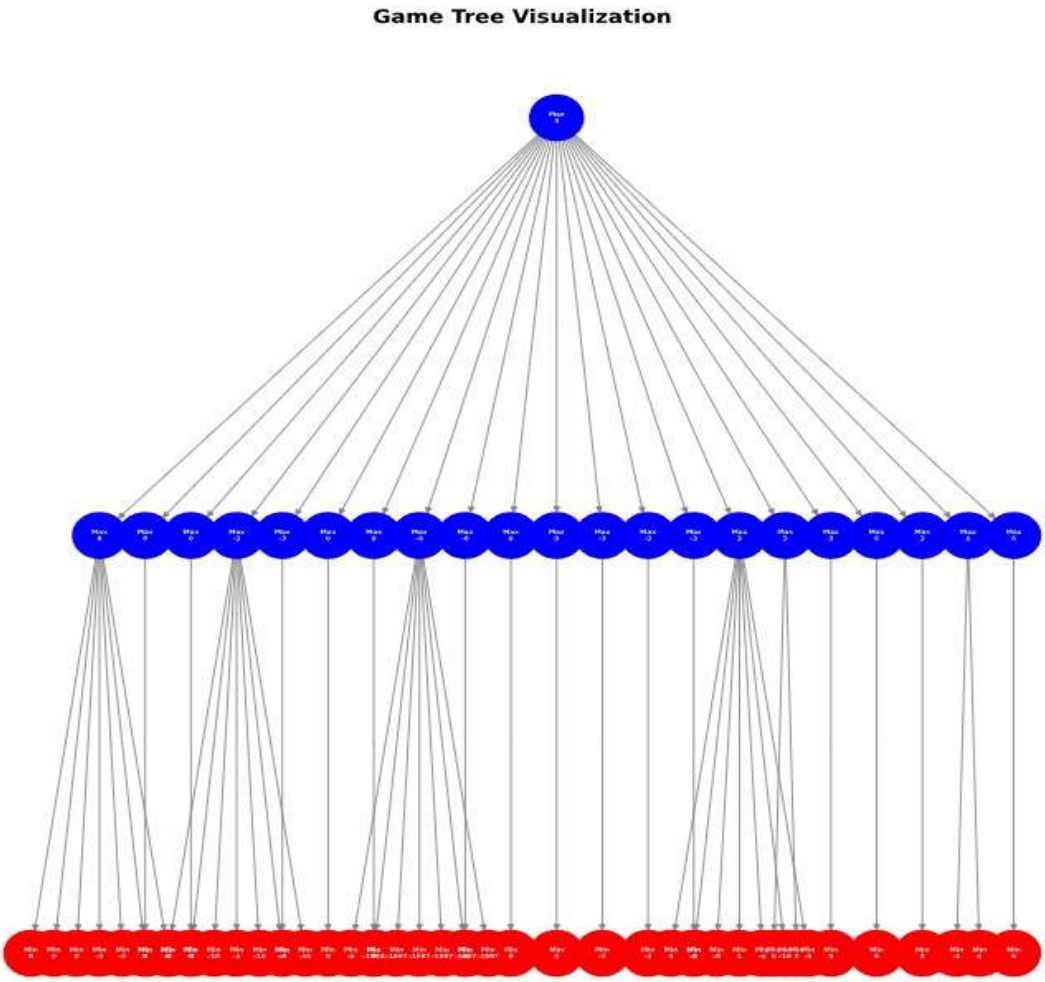
| 2 | 1 | 1 | 1 | 1 | 1 | 2 |

| 1 | 1 | 1 | 1 | 1 | 1 | 1 |

| 2 | 2 | 1 | 2 | 2 | 2 | 1 |

| 2 | 2 | 1 | 1 | 2 | 2 | 2 |

Time Taken 0.0005476474761962891



With normal MiniMax:

| 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| 0 | 0 | 0 | 2 | 0 | 0 | 0 |

Time Taken 0.479969024658203 1

| 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| 0 | 0 | 1 | 2 | 2 | 0 | 0 |

Time Taken 0.484888076782226 56

| 0 | 0 | 1 | 1 | 2 | 2 | 2 |

| 1 | 0 | 1 | 1 | 1 | 1 | 2 |

| 1 | 1 | 1 | 2 | 2 | 2 | 1 |

| 2 | 2 | 1 | 2 | 1 | 2 | 2 |

| 2 | 2 | 1 | 1 | 1 | 1 | 2 |

| 2 | 2 | 1 | 2 | 2 | 2 | 1 |

Time Taken 0.00180959701538085 94

| 0 | 2 | 1 | 1 | 2 | 2 | 2 |

| 1 | 1 | 1 | 1 | 1 | 1 | 1 |

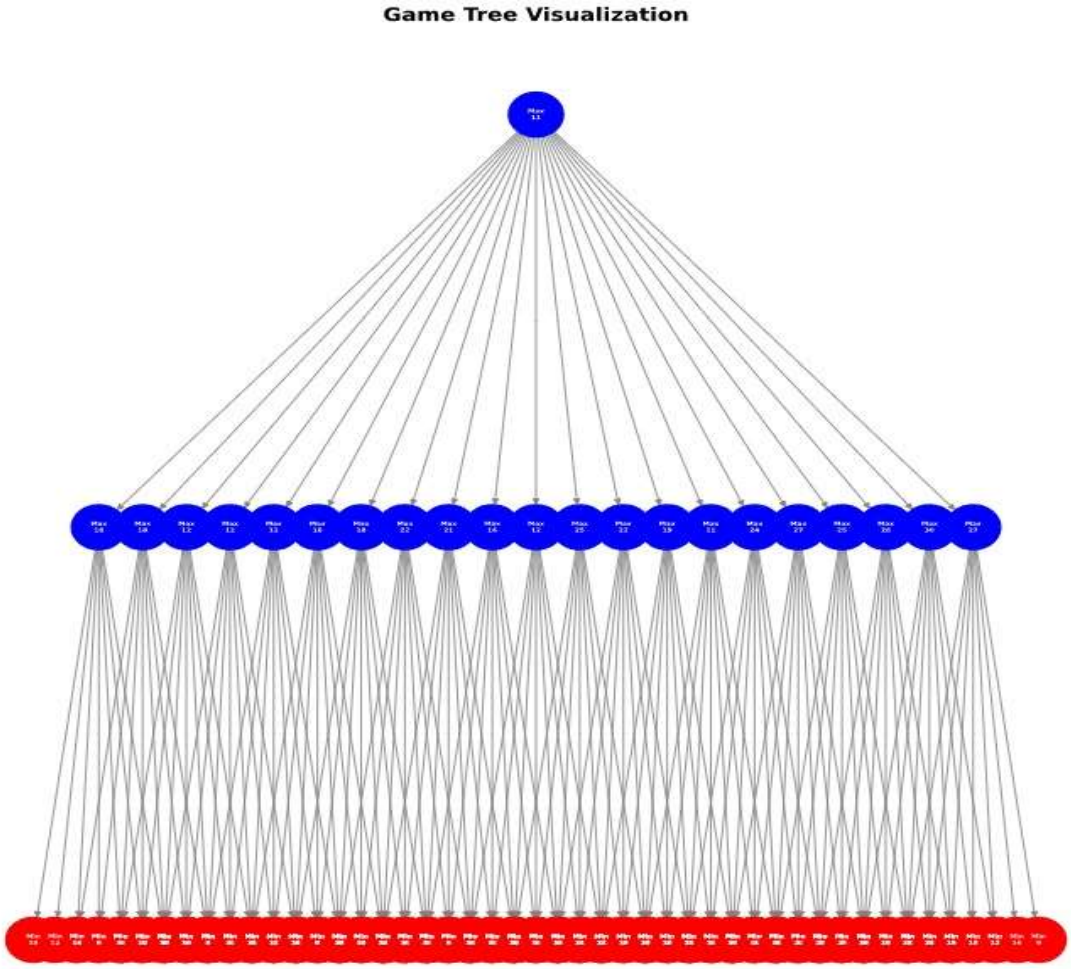
| 1 | 1 | 1 | 2 | 2 | 2 | 1 |

| 2 | 2 | 1 | 2 | 1 | 2 | 2 |

| 2 | 2 | 1 | 1 | 1 | 1 | 2 |

| 2 | 2 | 1 | 2 | 2 | 2 | 1 |

Time Taken 0.00033211708068847656



Expected MiniMax:

| 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| 0 | 0 | 0 | 0 | 0 | 0 | 0 |

Time Taken 0.08700704574584961

| 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| 0 | 0 | 0 | 1 | 2 | 0 | 0 |

Time Taken 0.5294327735900879

1 | 1 | 2 | 2 | 1 | 0 | 0 |

| 1 | 2 | 2 | 1 | 1 | 1 | 0 |

| 1 | 2 | 2 | 2 | 1 | 2 | 0 |

| 1 | 2 | 2 | 2 | 1 | 1 | 2 |

| 1 | 1 | 1 | 1 | 1 | 2 | 1 |

| 2 | 2 | 2 | 1 | 2 | 2 | 2 |

Time Taken 0.00286173820495605 47

| 1 | 1 | 2 | 2 | 1 | 0 | 0 |

| 1 | 2 | 2 | 1 | 1 | 1 | 2 |

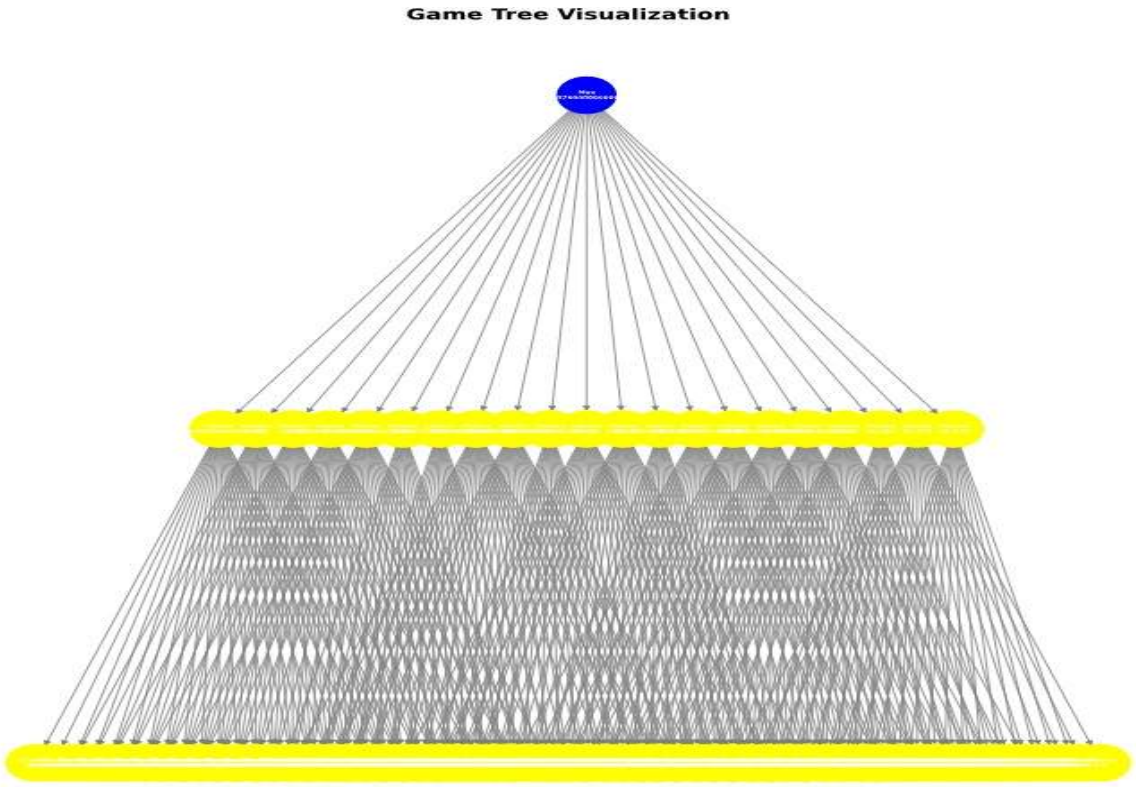
| 1 | 1 | 1 | 1 | 1 | 1 | 1 |

| 1 | 2 | 2 | 2 | 1 | 1 | 2 |

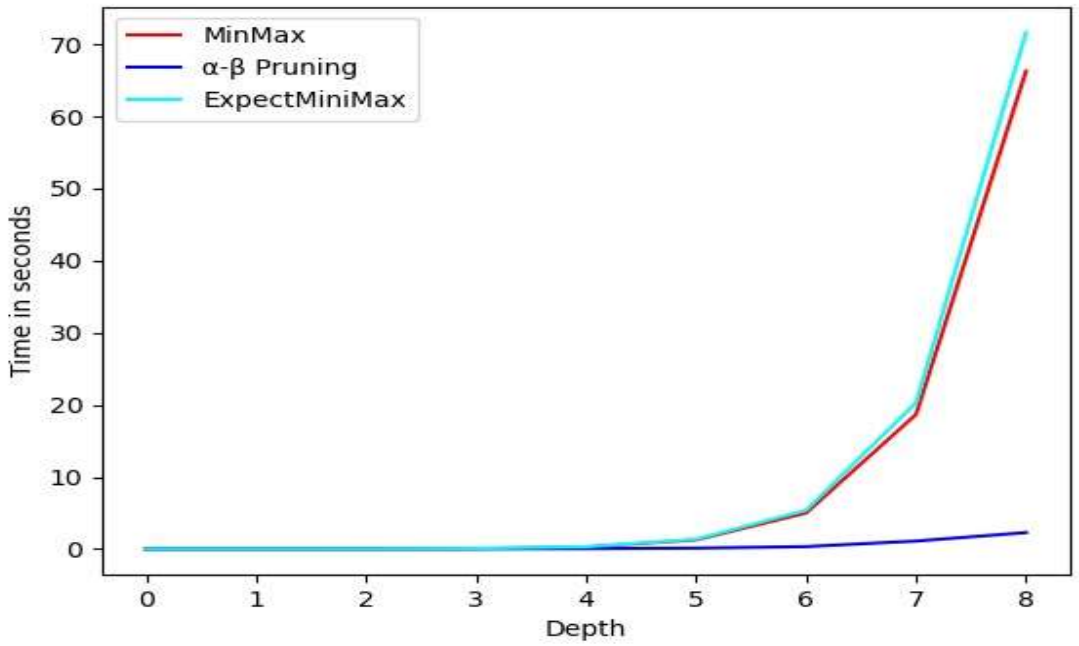
| 1 | 1 | 1 | 1 | 1 | 2 | 1 |

| 2 | 2 | 2 | 1 | 2 | 2 | 2 |

Time Taken 0.0010418891906738281


Game Tree Visualization

Comparison :


MinMax
α-β Pruning
ExpectMiniMax
Time in seconds
Depth
0
10
20
30
40
50
60
70
0
1
2
3
4
5
6
7
8
