Artificial Intelligence
Machine Problem 2 – Alpha/Beta Search

Introduction

For this assignment, you will implement the minimax algorithm with alpha-beta pruning in order to find the optimal move for a simple game. This game is played on a 4x4 board with the player starting in the lower left corner, and a monster in the upper left. One of the positions in the board contains gold. The player has to move (up, down, left, right) to reach the goal and come back to the starting position (to exit). The player can also build a wall in one of the four directions, if the square is empty. The monster can also move in the four directions and can also stay still (player must always build or move). The monster wants to eat the player, which happens when they become collocated.

Requirements

You are to modify the give base code program to implement the alpha-beta search for making the computer's move (it's random initially). This will require implementing additional methods for testing for terminal states and finding the utility of states, among others. You can follow the textbook's pseudocode for the algorithm.

Additional Requirements

1. The name of your source code file should be `mp2.py`. All your code should be within a single file.
2. You can only import numpy, random, and math packages.
3. Your code should follow good coding practices, including good use of whitespace and use of both inline and block comments.
4. You need to use meaningful identifier names that conform to standard naming conventions.
5. At the top of each file, you need to put in a block comment with the following information: your name, date, course name, semester, and assignment name.

What to Turn In

You will turn in the single mp2.py file using BlackBoard.

HINTS

- It's easiest to use the backtracking method. That is, instead of generating hypothetical states, just apply the moves to the game board, compute the utility, and then backtrack the move. This requires that you add a function to reverse whatever move was made.

Grading Rubric

Category	Unsatisfactory (0-1 points)	Satisfactory (2-3 point)	Distinguished (4-5 points)
Program Correctness	• Program does not execute due to errors • Incorrect results for most or all input	• Program works and completes most tasks appropriately • Program fails to work for special cases	• Program runs and completes all required tasks • Handles any required special cases • Executes without errors
Programming Style	• No name, date, or assignment title included • Poor use of white space • Disorganized and messy • No or few comments in the source code • Poor use of variables (improper scope/visibility, ambiguous naming).	• Includes name, date, and assignment title. • White space makes program fairly easy to read. • Well organized code. • Some comments missing in the source code or too many comments • Good use of variables (few issues with scope/visibility or unambiguous naming).	• Includes name, date, and assignment title. • Excellent use of white space. • Perfectly organized code. • Source code is commented throughout when needed • Excellent use of variables (no issues with scope/visibility or unambiguous naming).
Following Specifications	• Incorrect filenames • Incorrect specified identifier names • Source code organization different from requirements • Additional requirements not satisfied	• Correct filenames and class names • Few issues with other specified identifier names • Source code organization close to requirements • Some additional requirements not satisfied	• Correct filenames and specified identifier names • Source code organization satisfies all requirements • All additional requirements satisfied

Sample Output

```
CLASS: Artificial Intelligence, Lewis University
NAME: [put your name here]
  1 2 3 4
 ---------
1|W| | | |
 ---------
2| | |G| |
 ---------
3| | | | |
 ---------
4|P| | | |
 ---------
Player's Move # 1

Choose your move ['w', 'wb', 'd', 'db']: d
  1 2 3 4
 ---------
1|W| | | |
 ---------
2| | |G| |
 ---------
3| | | | |
 ---------
4| |P| | |
 ---------
Depth reached: 17
Number pruned due to a/b: 480344
  1 2 3 4
 ---------
1| | | | |
 ---------
2|W| |G| |
 ---------
3| | | | |
 ---------
4| |P| | |
 ---------
Player's Move # 2

Choose your move ['w', 'wb', 'a', 'ab', 'd', 'db']: w
  1 2 3 4
 ---------
1| | | | |
 ---------
2|W| |G| |
 ---------
3| |P| | |
 ---------
4| | | | |
 ---------
Depth reached: 15
Number pruned due to a/b: 205394
  1 2 3 4
 ---------
1|W| | | |
```

```
 ---------
2| | |G| |
 ---------
3| |P| | |
 ---------
4| | | | |
 ---------
Player's Move # 3

Choose your move ['w', 'wb', 's', 'sb', 'a', 'ab', 'd', 'db']: ab
  1 2 3 4
 ---------
1|W| | | |
 ---------
2| | |G| |
 ---------
3|#|P| | |
 ---------
4| | | | |
 ---------
Depth reached: 13
Number pruned due to a/b: 23996
  1 2 3 4
 ---------
1| | | | |
 ---------
2|W| |G| |
 ---------
3|#|P| | |
 ---------
4| | | | |
 ---------
Player's Move # 4

Choose your move ['w', 'wb', 's', 'sb', 'd', 'db']: d
  1 2 3 4
 ---------
1| | | | |
 ---------
2|W| |G| |
 ---------
3|#| |P| |
 ---------
4| | | | |
 ---------
Depth reached: 11
Number pruned due to a/b: 8451
  1 2 3 4
 ---------
1|W| | | |
 ---------
2| | |G| |
 ---------
3|#| |P| |
 ---------
4| | | | |
 ---------
```

```
Player's Move # 5

Choose your move ['w', 'wb', 's', 'sb', 'a', 'ab', 'd', 'db']: w
  1 2 3 4
 ---------
1|W| | | |
 ---------
2| | |P| |
 ---------
3|#| | | |
 ---------
4| | | | |
 ---------
Depth reached: 9
Number pruned due to a/b: 2300
  1 2 3 4
 ---------
1| | | | |
 ---------
2|W| |P| |
 ---------
3|#| | | |
 ---------
4| | | | |
 ---------
Player's Move # 6

Choose your move ['w', 'wb', 's', 'sb', 'a', 'ab', 'd', 'db']: s
  1 2 3 4
 ---------
1| | | | |
 ---------
2|W| | | |
 ---------
3|#| |P| |
 ---------
4| | | | |
 ---------
Depth reached: 7
Number pruned due to a/b: 744
  1 2 3 4
 ---------
1| | | | |
 ---------
2| |W| | |
 ---------
3|#| |P| |
 ---------
4| | | | |
 ---------
Player's Move # 7

Choose your move ['w', 'wb', 's', 'sb', 'a', 'ab', 'd', 'db']: s
  1 2 3 4
 ---------
1| | | | |
 ---------
```

```
2| |W| | |
 ---------
3|#| | | |
 ---------
4| | |P| |
 ---------
Depth reached: 5
Number pruned due to a/b: 92
  1 2 3 4
 ---------
1| | | | |
 ---------
2| | | | |
 ---------
3|#|W| | |
 ---------
4| | |P| |
 ---------
Player's Move # 8

Choose your move ['w', 'wb', 'a', 'ab', 'd', 'db']: a
  1 2 3 4
 ---------
1| | | | |
 ---------
2| | | | |
 ---------
3|#|W| | |
 ---------
4| |P| | |
 ---------
Depth reached: 3
Number pruned due to a/b: 6
  1 2 3 4
 ---------
1| | | | |
 ---------
2| | | | |
 ---------
3|#| | | |
 ---------
4| |W| | |
 ---------
GAME OVER
You Lost!
```