

Soi Engineering - Ain Shanno Ling.

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Code Main Functions

Print game

This function's purpose is to represent the console based UI, and to print the game array

in a form that is recognizable to the player.

Final

This function's purpose is to check whether or not the game is still going.

It takes the current game array as an input

Returns 1 if the player opposing to the bot finished all the stones in his pits.

Returns 2 if bot finished all the stones in all his 6 pits

Returns 0 if the game is still going.

```
1 def final(game):
                         Player's
       if sum(game[0:6]) == 0:
           game[13] += sum(game[7:13])
           for i in range(14):
 4
                if (i != 13 and i != 6):
                    game[i] = 0
           return 1
 8
                            Bot'
       elif sum (game(7:13)) == 0:
           game[6] += sum(game[0:6])
10
11
           for i in range(14):
12
               if (i != 13 and i != 6):
13
                    game[i] = 0
14
           return 2
15
       else:
16
           return 0
```

Move Game

```
    1 def movegame (borad_mancala, num_pit, stealing):
    2 num_seed = 0
    3 another_turn = False
```

```
num_pit_sent = num_pit
       if num pit sent < 6:</pre>
           num seed = borad mancala[num pit]
           borad mancala[num pit] = 0
           while (num seed != 0):
                                                         When changing
               num_pit += 1
                                                            player pits.
11
               num pit = num pit % 14
12
               if num pit == 13:
13
14
               borad mancala[num pit] += 1
15
               num_seed -= 1
16
               if (borad mancala[num pit] == 1 and borad mancala[
17
                   -num pit + 12] != 0 and num pit != 6 and num seed == 0 and stealing == 0):
                   borad mancala[6] += borad mancala[num pit] + borad mancala[-num pit + 12]
                   borad mancala[num pit] = 0
19
                   borad mancala[-num pit + 12] = 0
21
               if (num pit == 6 and num seed == 0):
                   another turn = True
23
       if num pit sent > 6:
24
           num seed = borad mancala[num pit]
25
           borad_mancala[num_pit] = 0
           while (num seed != 0):
                                                          When changing bot
27
               num pit += 1
                                                                   pits.
               num pit = num pit % 14
29
               if num pit == 6:
                   continue
               borad mancala[num pit] += 1
32
               num seed -= 1
               if (borad_mancala[num_pit] == 1 and borad_mancala[
                   5 - (\text{num pit } - 7)] != 0 and num pit != 13 and num seed == 0 and stealing == 0):
34
                   borad_mancala[13] += borad_mancala[num_pit] + borad_mancala[5 - (num_pit - 7)]
                   borad mancala[num pit] = 0
                   borad_mancala[5 - (num_pit - 7)] = 0
               if (num pit == 13 and num seed == 0):
38
                   another turn = True
       return another turn
```

This function's purpose is to change the values of the game array following the rules of mancala, it is adaptive to work in both stealing and no stealing case, it takes the current board, the pit chosen, and whether or not stealing will be applied.

Returns a bool to indicate whether or not a player will play again (in case the player's last stone falls into player's home).

Heuristic

```
• 1 def heuristic(game):
• 2    if final(game):
• 3         if game[13] > game[6]:
• 4             return 49
• 5         elif game[13] == game[6]:
• 6             return 0
• 7          else:
• 8             return -49
• 9         else:
• 10             return game[13] - game[6]
```

This function is responsible for heuristic value calculation, we chose the heuristic function to be the difference between the number of stones in both players' homes, we chose a maximum value of 49, because the best case (all stones in one home) is 48.

There were other possible functions like looking at the stones in the bot's home and maximizing them but this function neglects the number of stones in the opponents home, another function is to minimizing the opponent's stones, but it neglects the number of stones in the bot's home.

Other possible functions such as aiming for boards that give another turn or aiming for boards that makes bot have maximum stones in his pits(not home).

But after some research and thinking, we decided that the best function is the one we chose.

AlphaBeta

```
1 def alphabeta (currentgame, depth,
                                     alpha, beta, MinorMax, steal):
 2
       global num of nodes
                                      Supports Difficulty Levels
       if depth == 0 or final(currentgame) != 0:
 4
           hursvalue = heuristic(currentgame)
           verbose['NumofLeaf'] += 1
                                                       Changes depending on the
           verbose['values'].append(hursvalue)
                                                       turn/level we are now in.
           return hursvalue, -1
       if MinorMax:
           v = -1000
                                          When evaluating a
           move = -1
                                          Max node.
11
           for m in range(7, 13, 1):
12
               num of nodes +=1
13
               if currentgame[m] == 0: continue
14
               a = currentgame[:]
15
               minormax = movegame(a, m, steal)
16
               newv, = alphabeta(a, depth - 1, alpha, beta, minormax, steal)
17
               if v < newv:</pre>
18
                   move = m
```

```
19
                    v = newv
20
                alpha = max(alpha, v)
21
                if alpha >= beta:
22
                    verbose['numofCut'] += 1
23
                    verbose['levels'].append(depth)
24
                    break
25
            return v, move
26
       else:
                                                      When evaluating a
27
           v = 1000
                                                      Min node.
28
           move = -1
29
           for n in range (0, 6, 1):
30
                if currentgame[n] == 0: continue
31
                a = currentgame[:]
32
                minormax = movegame(a, n, steal);
33
                num of nodes +=1
34
                newv, = alphabeta(a, depth - 1, alpha, beta, not minormax, steal)
35
                if v > newv:
36
                    move = n
37
                    v = newv
38
                beta = min(beta, v)
39
                if alpha >= beta:
                    verbose['numofCut'] += 1
41
                    verbose['levels'].append(depth)
42
                    break
            return v, move
```

This function is the main decision-making algorithm, it is a recursive function that supports iterative depth allowing for multiple difficulty levels, supporting stealing and verbose mode, saving the info in a verbose.txt file.

Verbose functions

```
1 def storeVerbose(i):
       try:
           global num of nodes
           verbose['AverageBF'] = (verbose['NumofLeaf'] +
num of nodes)/(num of nodes+1)
           verbose file = open('verbose.txt', 'a')
           verbose file.write('Turn' + str(i) + ': ' + str(verbose)
+str(num of nodes) + '\n')
           verbose file.close()
           verbose['AverageBF'] = 0
           verbose['NumofLeaf'] = 0
10
           verbose['values'].clear()
11
           verbose['numofCut'] = 0
12
           verbose['levels'].clear()
```

```
num of nodes = 0
13
14
       except:
15
           print("Unable to write to file")
16
17
18 def delete verbose():
19
20
       f = open("verbose.txt", "w+")
21
22
23
       f.seek(0)
24
25
26
       f.truncate()
27
       f.close
```

These two functions are responsible for all data recording and documentation for every turn, all data is recorded in a dictionary and saved in a txt file.

Main Code

```
1 loop1=1 Flag
2 Newgame = [0 \text{ for } i \text{ in range}(14)]
                                                              Game array initialization
3 for i in range(0, 6, 1): Newgame[i] = 4
                                                              and clearing previously
4 for i in range(7, 13, 1): Newgame[i] = 4
                                                              recorded data.
5 delete verbose()
  while True:
      try:
          resume = input("New game or Resume ? 0:Newgame, 1:Resume\n")
          if resume.isdigit():
               resume = int(resume)
                                           This loop is responsible for all
          else:
                                           input possibilities after the bots
               raise ValueError()
                                           asks the player whether or not
          if resume==0:
                                           he wants to resume.
              break
          if resume==1:
               try:
                   if (path.exists("save.txt")):
                       filesize = os.path.getsize("save.txt")
                       if filesize == 0:
                            print("the file is empty")
                            resume = input("Enter the value 0 for a new game \n")
                   else:
                        raise ValueError()
               except ValueError:
                   print("There is no saved game, you will now play a new game")
```

```
resume=0
28
                    loop1=0
29
           raise ValueError()
30
       except ValueError:
                if loop1==0:
31
32
                    break
33
               print("Input must be 0 or 1.\n")
34
35 if resume==1:
36
       if (path.exists("save.txt")):
                                                  Data extraction from pre
37
           with open('save.txt','rb') as f:
                                                  saved file
38
               n,steal,diff=pickle.load(f)
39
           Newgame = n
40
           print('If the result is 0:With Stealing 1:Without Stealing\n', steal)
           print('If the difficulty is 0:easy 1:medium 2:hard\n', diff)
42
43
       else:
           print("file does not exit")
45
                           Taking input from user in case user chooses to play a new game.
   elif resume == 0:
48
       while True:
49
           try:
                turn = input("Who do you want to start? 0=YOU, 1=BOT\n")
                if turn.isdigit():
52
53
                    turn = int(turn)
54
                    raise ValueError()
56
57
                    break
58
                raise ValueError()
59
           except ValueError:
60
               print("Input must be 0 or 1.\n")
61
62
       while True:
63
               steal = input("Do you want stealing? 0=YES, 1=NO\n")
                if steal.isdigit():
                    steal = int(steal)
66
67
                else:
68
                    raise ValueError()
                if steal == 0 or steal == 1:
69
                    break
71
                raise ValueError()
           except ValueError:
72
                print("Input must be 0 or 1.\n")
73
74
```

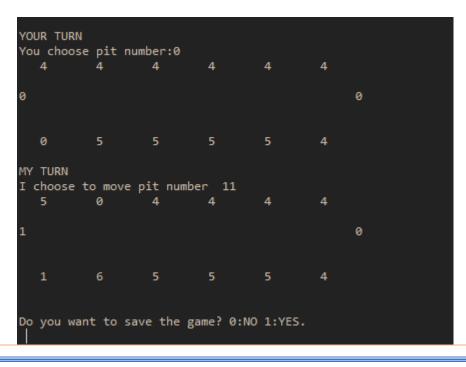
```
while True:
77
                 diff = input("Which difficulty level do you want? 0=easy, 1=medium,
 78
                 if diff.isdigit():
 79
                     diff = int(diff)
                     if diff == 0:
80
81
                         depth = 4
                     elif diff == 1:
 82
 83
                          depth = 8
 84
                     elif diff == 2:
 85
                          depth = 12
 86
                     verbose['Maxdepth'] = depth
                 else:
87
                     raise ValueError()
                 if diff == 0 or diff == 1 or diff == 2:
 89
 90
                 raise ValueError()
 92
            except ValueError:
 93
                 print("Input must be 0 or 1 or 2.\n")
 94
 95 i = 1
 96 \text{ count} = 2
 97 printgame (Newgame)
98 while (True): 		 Main loop
99
        if final(Newgame):
100
            whowon = Newgame[13] - Newgame[6]
101
            break
102
                                   Bot's turn
103
        while (turn == 1):
104
            if final(Newgame):
105
                 whowon = Newgame[13] - Newgame[6]
106
                 break
107
            print("MY TURN ")
            _, k = \text{alphabeta}(\text{Newgame}, \text{depth}, -1000, 1000, True, steal})
108
109
             print('I choose to move pit number ', k)
            t = movegame(Newgame, k, steal)
110
111
            printgame(Newgame)
112
            storeVerbose(i)
113
114
             if (not t):
115
                 turn = 0
                 break
116
```

```
118
        while (turn == 0):
                                          Player's Turn
119
            if final(Newgame):
120
121
            while (turn == 0):
122
                try:
123
                     save = input("Do you want to save the game? 0:NO 1:YES.\n ")
124
                     if save.isdigit():
125
                         save = int(save)
126
127
                         raise ValueError()
128
                     if save == 0 or save == 1:
129
                         break
130
                     raise ValueError()
131
                except ValueError:
                     print("Input must be 0 or 1.\n")
132
133
            if save == 1:
134
                with open("save.txt", "wb") as f:
135
                     pickle.dump([Newgame, steal, diff], f)
136
                sys.exit()
137
            else:
                while (turn == 0):
138
139
140
                         h = input("YOUR TURN\nYou choose pit number:")
141
                         if h.isdigit():
142
                             h = int(h)
143
                         else:
144
                             raise ValueError()
145
                         if h == 0 or h == 1 or h == 2 or h == 3 or h == 4 or h == 5:
146
                             break
                         raise ValueError()
147
148
                     except ValueError:
149
                         print("You must choose one of your own pits")
                if h > 5 or Newgame[h] == 0:
151
                    print('you can\'t play')
152
                     break
153
                t = movegame(Newgame, h, steal)
154
                printgame(Newgame)
155
                if (not t):
156
                     turn = 1
157
                     break
158
159 printgame (Newgame)
160 if (whowon > 0):
161
        print('I WIN. HA HA')
                                          Ending phrases
162 elif (whowon < 0):
163
        print('You won..')
164 elif (whowon == 0):
165
       print('Its a Tie')
```

User guide and snapshots

Snapshot

```
In [37]: runfile('D:/College/4th Computer/Term 2/Artificial Intellegence/Project/HagoorFinal.py', wdir='D:/
College/4th Computer/Term 2/Artificial Intellegence/Project')
New game or Resume ? 0:Newgame, 1:Resume
                                                  Wrong input
Input must be 0 or 1.
New game or Resume ? 0:Newgame, 1:Resume
                                                               Wrong input because there's no
There is no saved game, you will now play a new game
                                                               previously saved game
Who do you want to start? 0=YOU, 1=BOT
                                                 Normal Dialogue
Do you want stealing? 0=YES, 1=NO
Which difficulty level do you want? 0=easy, 1=medium, 2=hard
                                                    0
Do you want to save the game? 0:NO 1:YES.
YOUR TURN
You choose pit number:
```



```
MY TURN
I choose to move pit number 11
5 0 4 4 4 4

1 0

1 6 5 5 5 4

Do you want to save the game? 0:NO 1:YES.
2
Input must be 0 or 1.

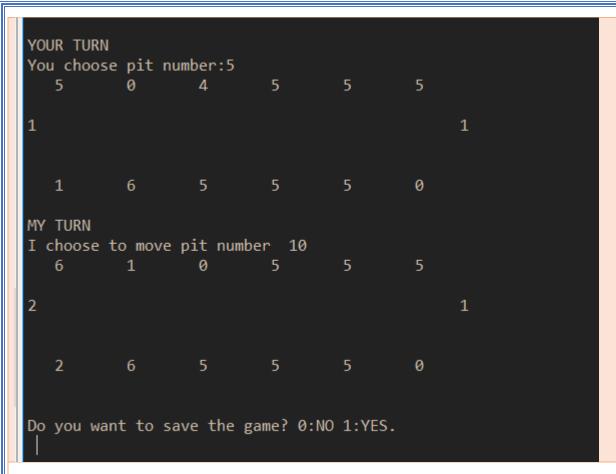
Do you want to save the game? 0:NO 1:YES.
1
```

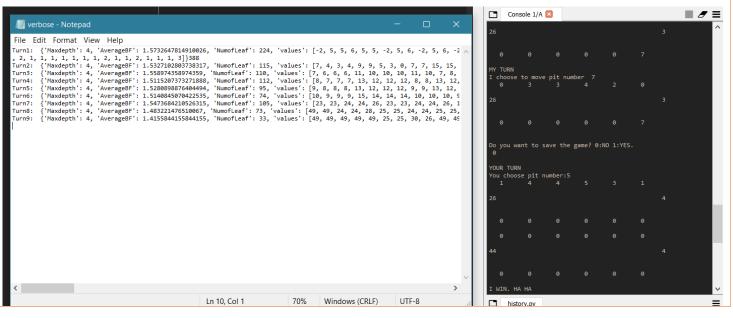
```
New game or Resume ? 0:Newgame, 1:Resume
5
Input must be 0 or 1.

New game or Resume ? 0:Newgame, 1:Resume
1
If the result is 0:With Stealing 1:Without Stealing
0
If the difficulty is 0:easy 1:medium 2:hard
2
6 0 0 0 4 4
9 0

5 0 5 5 5

Do you want to save the game? 0:NO 1:YES.
0
YOUR TURN
```





MY TURN							
I choose				_			
7	2	1	7	7	0		
3						2	
3						2	
2	6	5	5	0	1		
MY TURN							
I choose				_			
8	0	1	7	7	0		
4						2	
-						2	
2	6	5	5	0	1		
MY TURN	A		10				
I choose 8			nber 10 7	7	0		
0	v	V	,	,	V		
11						2	
2	0	5	5	0	1		

Work division

	Alpha Beta Algorithm	Movement Algorithm	Main Loop	Heuristic Calculation	Final function	Printing function	Report	Verbose	Save and load
Hajr Rizk	√		√			√		√	
Yara Ismail	√		√			√	√		
Hadeer Fawzy		√	√			√			√
Nouran Khaled		√	√			√			√
Hassan Mostafa			√	√	√		✓		

Youtube link

https://youtu.be/x\$8gG63y7m8

Github link

https://github.com/YaraFekri/MancalaAl