CS480 Programming Assignment 01

Youngjo Choi (A20522730)

Analysis:

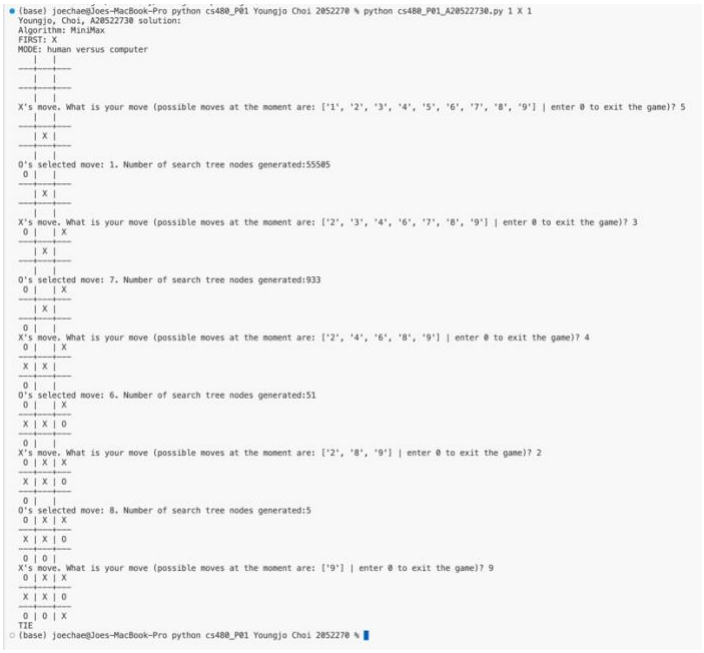
Play nine (9) human versus computer (**using both algorithms**) games, each starting with a different move. Count the total number of expanded nodes (sum of expanded nodes for every computer move) and report them in the table below.

Your (X) First move	Computer (0) with MiniMax algorithm. Total (for every move) number of generated nodes	Computer (0) with MiniMax with alpha beta pruning algorithm. Total (for every move) number of generated nodes
1	59705 + 927 + 61 + 5 = 60698	2338 + 112 + 29 + 5 = 2484
2	63905 + 1055 + 53 + 5 = 65018	2869 + 269 + 19 + 5 = 3162
3	59705 + 935 + 47 + 5 = 60692	3275 + 112 + 29 + 5 = 3421
4	63905 + 1055 + 53 + 5 = 65018	3574 + 179 + 33 + 5 = 3791
5	55505 + 933 + 51 + 5 = 56494	2316 + 230 + 33 + 5 = 2584
6	63905 + 1055 + 51 + 5 = 65016	3590 + 209 + 34 + 5 = 3838
7	59705 + 927 + 61 + 5 = 60698	3809 + 189 + 33 + 5 = 4036
8	63905 + 1019 + 51 + 5 = 64980	4981 + 189 + 33 + 5 = 5208
9	59705 + 927 + 61 + 5 = 60698	3957 + 275 + 47 + 5 = 4284

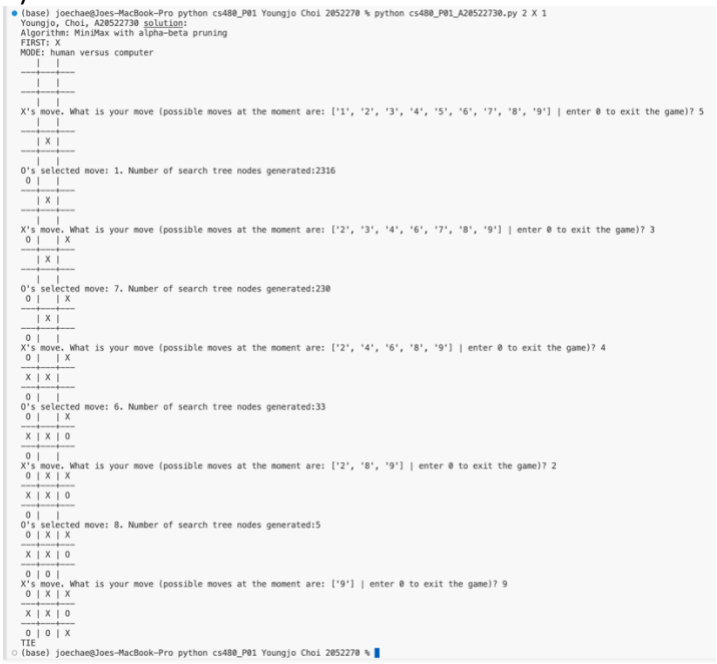
Results

I will demonstrate all 8 cases:

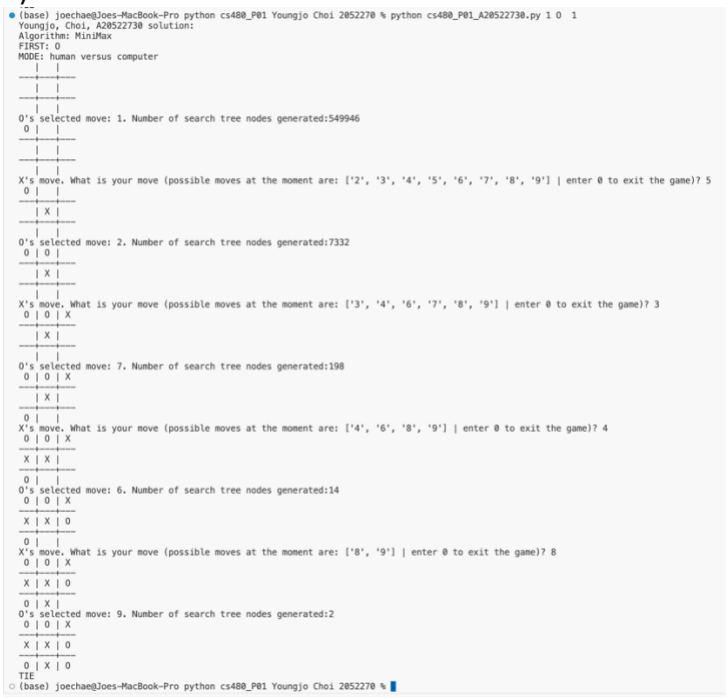
1) 1 X 1



2) 2 X 1



3) 1 O 1


(base) joechae@Joes-MacBook-Pro python cs480_P01 Youngjo Choi 2052270 % python cs480_P01_A20522730.py 1 O 1
Youngjo, Choi, A20522730 solution:
Algorithm: MiniMax
FIRST: O
MODE: human versus computer
O's selected move: 1. Number of search tree nodes generated:549946
X's move. What is your move (possible moves at the moment are: ['2', '3', '4', '5', '6', '7', '8', '9'] | enter 0 to exit the game)? 5
O's selected move: 2. Number of search tree nodes generated:7332
X's move. What is your move (possible moves at the moment are: ['3', '4', '6', '7', '8', '9'] | enter 0 to exit the game)? 3
O's selected move: 7. Number of search tree nodes generated:198
X's move. What is your move (possible moves at the moment are: ['4', '6', '8', '9'] | enter 0 to exit the game)? 4
O's selected move: 6. Number of search tree nodes generated:14
X's move. What is your move (possible moves at the moment are: ['8', '9'] | enter 0 to exit the game)? 8
O's selected move: 9. Number of search tree nodes generated:2
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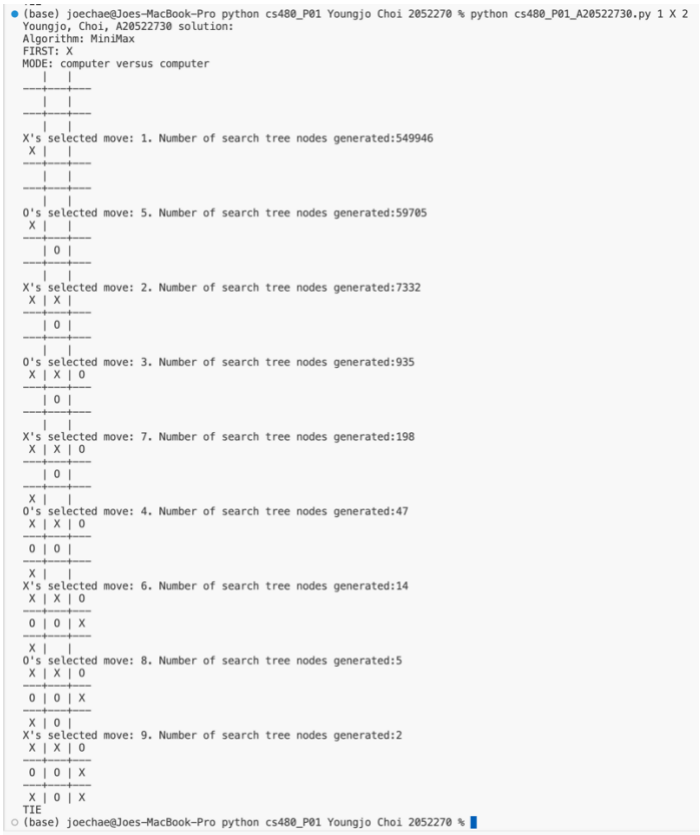
4) 1 X 2


(base) joechae@Joes-MacBook-Pro python cs480_P01 Youngjo Choi 2052270 % python cs480_P01_A20522730.py 1 X 2
Youngjo, Choi, A20522730 solution:
Algorithm: MiniMax
FIRST: X
MODE: computer versus computer
X's selected move: 1. Number of search tree nodes generated:549946
O's selected move: 5. Number of search tree nodes generated:59705
X's selected move: 2. Number of search tree nodes generated:7332
O's selected move: 3. Number of search tree nodes generated:935
X's selected move: 7. Number of search tree nodes generated:198
O's selected move: 4. Number of search tree nodes generated:47
X's selected move: 6. Number of search tree nodes generated:14
O's selected move: 8. Number of search tree nodes generated:5
X's selected move: 9. Number of search tree nodes generated:2
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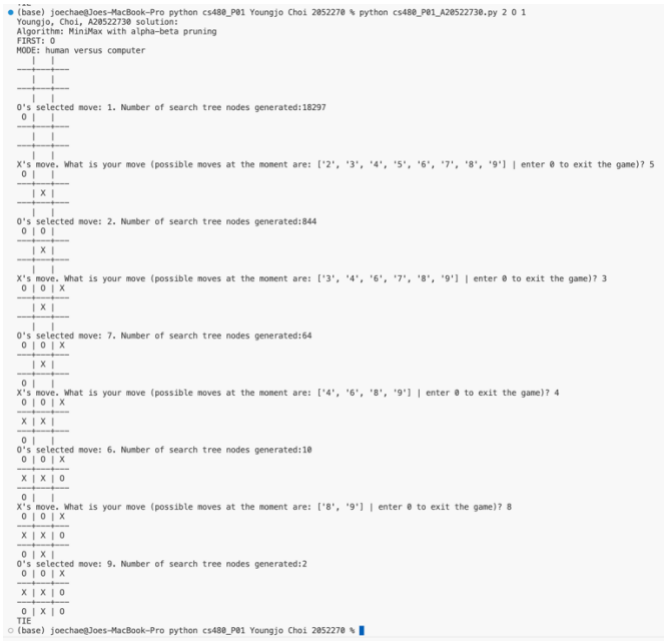
5) 2 O 1


(base) joechae@Joes-MacBook-Pro python cs480_P01 Youngjo Choi 2052270 % python cs480_P01_A20522730.py 2 O 1
Youngjo, Choi, A20522730 solution:
Algorithm: MiniMax with alpha-beta pruning
FIRST: O
MODE: human versus computer
O's selected move: 1. Number of search tree nodes generated:18297
X's move. What is your move (possible moves at the moment are: ['2', '3', '4', '5', '6', '7', '8', '9'] | enter 0 to exit the game)? 5
O's selected move: 2. Number of search tree nodes generated:844
X's move. What is your move (possible moves at the moment are: ['3', '4', '6', '7', '8', '9'] | enter 0 to exit the game)? 3
O's selected move: 7. Number of search tree nodes generated:64
X's move. What is your move (possible moves at the moment are: ['4', '6', '8', '9'] | enter 0 to exit the game)? 4
O's selected move: 6. Number of search tree nodes generated:10
X's move. What is your move (possible moves at the moment are: ['8', '9'] | enter 0 to exit the game)? 8
O's selected move: 9. Number of search tree nodes generated:2
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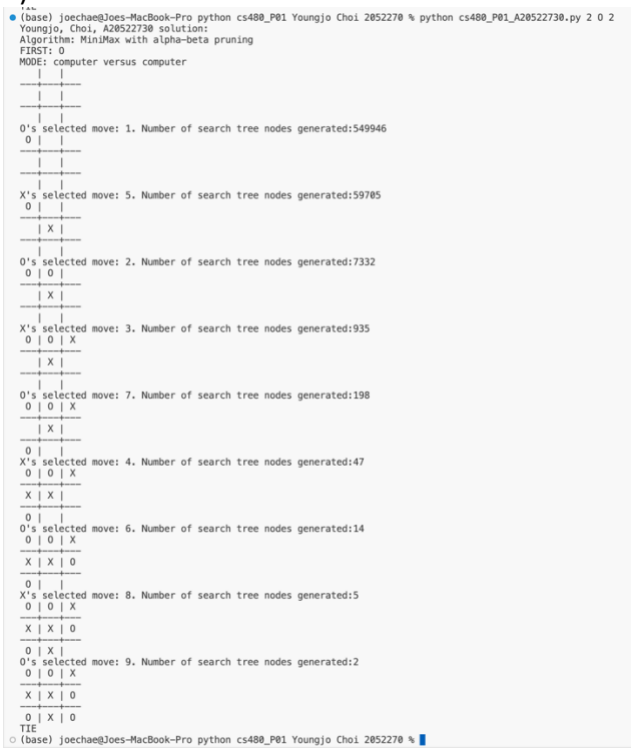
6) 2 O 2


(base) joechae@Joes-MacBook-Pro python cs480_P01 Youngjo Choi 2052270 % python cs480_P01_A20522730.py 2 O 2
Youngjo, Choi, A20522730 solution:
Algorithm: MiniMax with alpha-beta pruning
FIRST: O
MODE: computer versus computer
O's selected move: 1. Number of search tree nodes generated:549946
X's selected move: 5. Number of search tree nodes generated:59705
O's selected move: 2. Number of search tree nodes generated:7332
X's selected move: 3. Number of search tree nodes generated:935
O's selected move: 7. Number of search tree nodes generated:198
X's selected move: 4. Number of search tree nodes generated:47
O's selected move: 6. Number of search tree nodes generated:14
X's selected move: 8. Number of search tree nodes generated:5
O's selected move: 9. Number of search tree nodes generated:2
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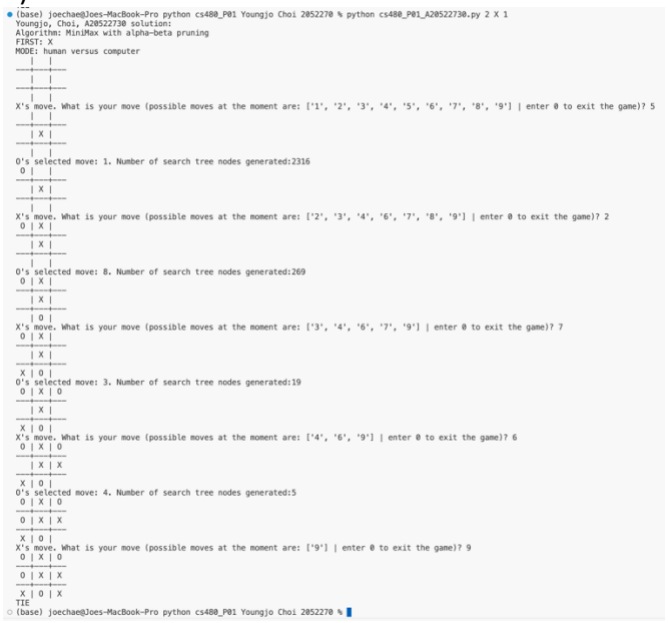
7) 2 X 1


(base) joechae@Joes-MacBook-Pro python cs480_P01 Youngjo Choi 2052270 % python cs480_P01_A20522730.py 2 X 1
Youngjo, Choi, A20522730 solution:
Algorithm: MiniMax with alpha-beta pruning
FIRST: X
MODE: human versus computer
X's move. What is your move (possible moves at the moment are: ['1', '2', '3', '4', '5', '6', '7', '8', '9'] | enter 0 to exit the game)? 5
O's selected move: 1. Number of search tree nodes generated:2316
X's move. What is your move (possible moves at the moment are: ['2', '3', '4', '6', '7', '8', '9'] | enter 0 to exit the game)? 2
O's selected move: 8. Number of search tree nodes generated:269
X's move. What is your move (possible moves at the moment are: ['3', '4', '6', '7', '9'] | enter 0 to exit the game)? 7
O's selected move: 3. Number of search tree nodes generated:19
X's move. What is your move (possible moves at the moment are: ['4', '6', '9'] | enter 0 to exit the game)? 6
O's selected move: 4. Number of search tree nodes generated:5
X's move. What is your move (possible moves at the moment are: ['9'] | enter 0 to exit the game)? 9
TIE
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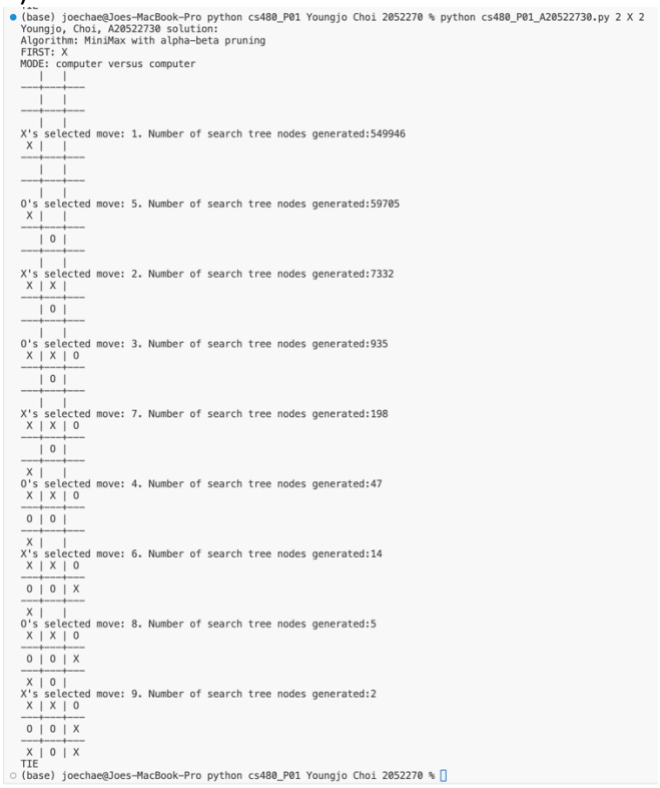
8) 2 X 2


(base) joechae@Joes-MacBook-Pro python cs480_P01 Youngjo Choi 2052270 % python cs480_P01_A20522730.py 2 X 2
Youngjo, Choi, A20522730 solution:
Algorithm: MiniMax with alpha-beta pruning
FIRST: X
MODE: computer versus computer
X's selected move: 1. Number of search tree nodes generated:549946
O's selected move: 5. Number of search tree nodes generated:59705
X's selected move: 2. Number of search tree nodes generated:7332
O's selected move: 3. Number of search tree nodes generated:935
X's selected move: 7. Number of search tree nodes generated:198
O's selected move: 4. Number of search tree nodes generated:47
X's selected move: 6. Number of search tree nodes generated:14
O's selected move: 8. Number of search tree nodes generated:5
X's selected move: 9. Number of search tree nodes generated:2
TIE
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Conclusion

What are your conclusions? Which algorithm performed better? Write a short summary below.

As we can see from the analysis, the number of expanded nodes is significantly less in MiniMax with alpha-beta pruning algorithm. That means it takes less time to traverse nodes in finding the optimal solution.

When I choose human(X) versus computer mode(O), and play it, whether it was MiniMax or MiniMax with alpha-beta pruning, the results I can get are only tie or loss. It represents that both MiniMax and MiniMax with alpha-beta pruning achieve the same desired outcome.

As a result, given the information above, we can say Minmax with alpha-beta pruning performs better than MiniMax algorithm.