Performance of Monte Carlo Agent

The algorithm I implemented is Monte Carlo Tree Search. After running 100 games, my agent won 20/100 matches, meaning it had a 20% winrate against the random player.

Majority of the games were draws due to threefold repetition which means the same board was made 3 times within a game.

The agent I designed can be improved because the game times were extremely long in some cases due to the number of possible moves in board states so simulations took longer to complete.

One approach I did but did not put in final code to keep traditional MCTS algorithm is a depth limit of the search tree. This would limit the amount of simulations that needed to be done so it would complete faster. I added a limit for testing and found that games lasted less time than without a simulation limit.

I also went with a balanced value for the UCB formula it uses for scoring nodes and determining which one to take to observe the moves made in the game. Choosing a lower value would have made the games much faster due to more aggresive options.

My agent took short amounts of time to make moves in the early game due to boards having similar score values. Once the game has a few moves done which is near the mid game, the time would increase which makes sense because

there are more pieces now that have multiple options to take and the board is more open, so there are more possibilities to run for each board, resulting in longer simulation time. More into the late game, the time to make moves decreased because there are less pieces now

so there are less moves to choose from so simulations go faster.

	Color of Agent	Time duration of game	Winner			Sample Times	Time taken in game 41		Time taken in game 6		Time taken in game 92
Game 1	Black	3092.28 seconds	Loss vs RandomPlayer	L	Loss: 25		2.62 seconds		2.67 seconds		2.61 seconds
Game 2	White	2576.99 seconds	Draw by threefold	D	Draw: 55		2.62 seconds		2.79 seconds		2.55 seconds
Game 3	Black	1394.48 seconds	Agent wins	W	Wins: 20		2.15 seconds		2.59 seconds		2.50 seconds
Game 4	White	3784.63 seconds	Draw by threefold	D			2.23 seconds		3.35 seconds		2.78 seconds
Game 5	Black	2381.24 seconds	Agent wins	W			2.33 seconds		3.33 seconds		2.73 seconds
Game 6	White	821.76 seconds	Agent wins	W			2.27 seconds		3.46 seconds		3.07 seconds
Game 7	Black	4301.76 seconds	Draw by threefold	D			4.44 seconds		3.24 seconds		2.68 seconds
Game 8	White	2885.04 seconds	Loss vs RandomPlayer	L			4.26 seconds		2.96 seconds		2.48 seconds
Game 9	Black	3930.67 seconds	Draw by threefold	D			4.86 seconds		2.98 seconds		2.39 seconds
Game 10	White	2967.02 seconds	Draw by threefold	D			4.72 seconds		3.25 seconds		4.37 seconds
Game 11	Black	4876.19 seconds	Draw by threefold	D			7.05 seconds		3.34 seconds		6.92 seconds
Game 12	White	1000.49 seconds	Loss vs RandomPlayer	L			7.96 seconds		3.57 seconds		7.25 seconds
Game 13	Black	4072.18 seconds	Draw by threefold	D			7.46 seconds		3.26 seconds		6.22 seconds
Game 14	White	3030.38 seconds	Loss vs RandomPlayer	L			9.03 seconds		5.46 seconds		6.31 seconds
Game 15	Black	3796.70 seconds	Draw by threefold	D			8.12 seconds		5.15 seconds		6.28 seconds
Game 16	White	4229.05 seconds	Loss vs RandomPlayer	L			5.71 seconds		6.00 seconds		8.71 seconds
Game 17	Black	4312.56 seconds	Draw by threefold	D			6.26 seconds		7.40 seconds		7.83 seconds
Game 18	White	4914.68 seconds	Draw by threefold	D			5.76 seconds		5.76 seconds		7.51 seconds
Game 19	Black	696.66 seconds	Agent wins	W			12.55 seconds		4.40 seconds		10.79 seconds
Game 20	White	3796.07 seconds	Draw by threefold	D			11.65 seconds		4.75 seconds		10.98 seconds
Game 21	Black	3026.96 seconds	Draw by threefold	D			7.92 seconds		5.23 seconds		9.15 seconds
Game 22	White	4304.23 seconds	Loss vs RandomPlayer	L			8.66 seconds		5.42 seconds		8.15 seconds
Game 23	Black	3474.70 seconds	Loss vs RandomPlayer	L			8.99 seconds		4.77 seconds		10.15 seconds
Game 24	White	6387.86 seconds	Loss vs RandomPlayer	L			9.77 seconds		5.29 seconds		11.05 seconds
Game 25	Black	1596.41 seconds	Agent wins	W			9.37 seconds		6.75 seconds		6.60 seconds
Game 26	White	4563.37 seconds	Draw by threefold	D			8.21 seconds		7.32 seconds		6.11 seconds
Game 27	Black	2678.82 seconds	Draw by threefold	D			6.35 seconds		8.86 seconds		7.70 seconds
Game 28	White	35.24 seconds	Draw by threefold	D			6.60 seconds		9.94 seconds		3.91 seconds
Game 29	Black	4781.32 seconds	Draw by threefold	D			8.02 seconds		10.49 seconds		4.42 seconds
Game 30	White	35.66 seconds	Draw by threefold	D			7.05 seconds		9.93 seconds		7.81 seconds
Game 31	Black	3210.97 seconds	Draw by threefold	D			8.28 seconds		9.29 seconds		8.17 seconds
Game 32	White	36.21 seconds	Draw by threefold	D			8.73 seconds		6.50 seconds		3.97 seconds
Game 33	Black	2997.62 seconds	Loss vs RandomPlayer	L			4.46 seconds		8.26 seconds		4.22 seconds
Game 34	White	36.46 seconds	Draw by threefold	D			4.57 seconds		14.04 seconds		4.53 seconds
Game 35	Black	3849.54 seconds	Loss vs RandomPlayer	L			3.79 seconds		13.40 seconds		3.58 seconds
Game 36	White	36.32 seconds	Draw by threefold	D			4.44 seconds		8.18 seconds		3.93 seconds
Game 37	Black	4038.06 seconds	Draw by threefold	D			3.34 seconds		9.81 seconds		3.64 seconds
Game 38	White	3974.56 seconds	Draw by threefold	D			4.97 seconds		9.53 seconds		3.97 seconds
Game 39	Black	2615.45 seconds	Draw by threefold	D			5.45 seconds		15.61 seconds		3.37 seconds
Game 40	White	1378.12 seconds	Agent wins	W			3.73 seconds		14.90 seconds		4.21 seconds
Game 41	Black	548.24 seconds	Draw by threefold	D			4.19 seconds		15.76 seconds		4.33 seconds
Game 42	White	4058.35 seconds	Draw by threefold	D			4.04 seconds		20.94 seconds		3.97 seconds
Game 43	Black	3476.87 seconds	Draw by threefold	D			3.64 seconds		20.85 seconds		1.52 seconds
Game 44	White	4732.09 seconds	Draw by threefold	D			3.79 seconds		17.69 seconds		3.42 seconds
Game 45	Black	4283.14 seconds	Draw by threefold	D			4.05 seconds		19.94 seconds		3.48 seconds
Game 46	White	3216.90 seconds	Draw by threefold	D			4.72 seconds		19.38 seconds		3.20 seconds
Game 47	Black	3010.41 seconds	Draw by threefold	D			3.29 seconds		19.45 seconds		6.00 seconds
Game 48	White	2267.68 seconds	Loss vs RandomPlayer	L			3.98 seconds		14.83 seconds		5.45 seconds
Game 49	Black	1735.90 seconds	Loss vs RandomPlayer	L			4.09 seconds		15.53 seconds		2.71 seconds
Game 50	White	4783.95 seconds	Draw by threefold	D			3.07 seconds		15.29 seconds		3.32 seconds
Game 51	Black	1187.95 seconds	Agent wins	W			2.68 seconds		13.51 seconds		3.44 seconds
Game 52	White	2288.63 seconds	Loss vs RandomPlayer	L			3.15 seconds		12.79 seconds		3.76 seconds
Game 53	Black	3859.42 seconds	Draw by threefold	D			3.88 seconds		9.72 seconds		3.60 seconds
Game 54	White	3090.32 seconds	Loss vs RandomPlayer	L			4.52 seconds		10.44 seconds		1.59 seconds
Game 55	Black	1689.12 seconds	Loss vs RandomPlayer	L			4.73 seconds		11.92 seconds		1.73 seconds
Game 56	White	4209.43 seconds	Draw by threefold	D			3.71 seconds		11.52 seconds		1.70 seconds
Game 57	Black	4064.47 seconds	Draw by threefold	D			4.15 seconds		12.65 seconds		1.28 seconds
Game 58	White	3310.69 seconds	Loss vs RandomPlayer	L			2.61 seconds		13.27 seconds		1.63 seconds
Game 59	Black	4468.98 seconds	Draw by threefold	D			2.60 seconds		7.57 seconds		1.13 seconds
Game 60	White	3477.66 seconds	Draw by threefold	D			2.53 seconds		10.31 seconds		1.11 seconds
Game 61	Black	1005.93 seconds	Agent wins	W			0.53 seconds		11.04 seconds		1.13 seconds
Game 62	White	2252.34 seconds	Loss vs RandomPlayer	L			0.83 seconds		12.49 seconds		1.33 seconds
Game 63	Black	3748.31 seconds	Draw by threefold	D			0.66 seconds		12.54 seconds		1.00 seconds
Game 64	White	2003.48 seconds	Agent wins	W			0.52 seconds		13.38 seconds		1.00 seconds
Game 65	Black	1908.34 seconds	Agent wins	W			0.71 seconds		12.33 seconds		1.00 seconds
Game 66	White	3090.32 seconds	Draw by threefold	D			0.25 seconds		8.02 seconds		1.25 seconds
Game 67	Black	841.19 seconds	Agent wins	W			2.40 seconds		7.92 seconds		1.21 seconds

Game 68		White		3955.29 seconds		Draw by threefold	D			1.84 seconds			6.36 seconds			1.22 seconds	
Game 69		Black		3310.69 seconds		Draw by threefold	D			2.87 seconds			7.32 seconds			1.07 seconds	
Game 70		White		2080.51 seconds		Loss vs RandomPlayer	L			2.54 seconds			6.09 seconds			1.23 seconds	
Game 71		Black		3193.37 seconds		Agent wins	W			1.94 seconds			6.53 seconds			1.04 seconds	
Game 72		White		1731.54 seconds		Loss vs RandomPlayer	L			2.01 seconds			5.68 seconds			1.13 seconds	
Game 73		Black		4377.01 seconds		Loss vs RandomPlayer	L			2.61 seconds			5.46 seconds			1.04 seconds	
Game 74		White		1487.78 seconds		Agent wins	W			3.36 seconds			5.09 seconds			1.05 seconds	
Game 75		Black		3036.46 seconds		Draw by threefold	D			2.06 seconds			4.08 seconds			1.01 seconds	
Game 76		White		2113.5 seconds		Agent wins	W			1.73 seconds			3.59 seconds			1.15 seconds	
Game 77		Black		3600.36 seconds		Draw by threefold	D			2.69 seconds			1.61 seconds			1.02 seconds	
Game 78		White		4327.53 seconds		Draw by threefold	D			2.27 seconds			4.66 seconds			0.90 seconds	
Game 79		Black		1131.68 seconds		Loss vs RandomPlayer	L			2.32 seconds			3.80 seconds			0.80 seconds	
Game 80		White		3634.76 seconds		Agent wins	W			2.80 seconds			3.63 seconds			0.86 seconds	
Game 81		Black		4632.33 seconds		Draw by threefold	D			0.80 seconds			4.17 seconds			0.81 seconds	
Game 82		White		4724.38 seconds		Draw by threefold	D			1.03 seconds			4.15 seconds			1.08 seconds	
Game 83		Black		4896.75 seconds		Loss vs RandomPlayer	L			0.76 seconds			3.84 seconds			1.56 seconds	
Game 84		White		2509.45 seconds		Agent wins	W			0.83 seconds			3.42 seconds			0.78 seconds	
Game 85		Black		1140.98 seconds		Loss vs RandomPlayer	L			2.72 seconds			4.41 seconds			0.76 seconds	
Game 86		White		3383.52 seconds		Agent wins	W			2.18 seconds			5.01 seconds			0.75 seconds	
Game 87		Black		1160.32 seconds		Agent wins	W			2.34 seconds			2.07 seconds			0.66 seconds	
Game 88		White		2818.4 seconds		Draw by threefold	D			0.89 seconds			2.52 seconds			0.67 seconds	
Game 89		Black		2906.72 seconds		Draw by threefold	D			2.71 seconds			2.22 seconds			0.78 seconds	
Game 90		White		3075.87 seconds		Draw by threefold	D			2.18 seconds			2.28 seconds			0.90 seconds	
Game 91		Black		1008.87 seconds		Agent wins	W			1.91 seconds			1.71 seconds			0.75 seconds	
Game 92		White		546.22 seconds		Draw by threefold	D			0.80 seconds			2.38 seconds			0.81 seconds	
Game 93		Black		3755.38 seconds		Draw by threefold	D			1.99 seconds			2.38 seconds			0.75 seconds	
Game 94		White		2787.93 seconds		Draw by threefold	D			0.83 seconds			2.14 seconds			0.84 seconds	
Game 95		Black		3926.81 seconds		Draw by threefold	D			2.02 seconds			2.22 seconds			0.78 seconds	
Game 96		White		1885.63 seconds		Draw by threefold	D			2.47 seconds			2.28 seconds			0.82 seconds	
Game 97		Black		4076.97 seconds		Draw by threefold	D			2.45 seconds			2.06 seconds			1.00 seconds	
Game 98		White		2108.7 seconds		Loss vs RandomPlayer	L			2.42 seconds			0.50 seconds			1.01 seconds	
Game 99		Black		2114.63 seconds		Loss vs RandomPlayer	L			2.30 seconds			0.45 seconds			1.01 seconds	
Game 100		White		1395 seconds		Agent wins	W			2.47 seconds			0.82 seconds			1.41 seconds	
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