COMP 472 - Mini Project 2

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Heuristic 1

- Counts available lines for X, O to win
- Checks every line of size s around every tile
- If no O and rest empty: X_win + 1
- If no X and rest empty: O_win + 1
- returns O_win - X_win

- easier than e2, but still 4 lists for every tile every round
- evaluation time with d=6, n=8, s=5 first move: 4.68s

Heuristic 2

- Assigns a positive value to every n-in-a-row the player X has
- A negative value to every n-in-a-row Player O has
- An n-in-a-row is worth about an order of magnitude more than an (n-1)-in-a-row
- Player O rows are slightly worth more than Player X
- This encourage player X to block before building its own row which makes this heuristic more defensive than heuristic 1.

- evaluation time with d=6, n=8, s=5 first move: 4.76s

Resolving Time Constraint

Option 1 (alphabeta)

- Reduce max_depth in search in 2 steps
- allows using most of the time → never violates constraint

Option 2 (minimax)

- return worst-case value for all nodes if leftover time is too low
- don't lose good deep evaluations

- makes comparing heuristics more difficult

Performance with same depths

Expectation: e1 should win more since e2 is looking to block first

	e1	e2	tie	
4435	20%	10%	70%	both player have similar number of wins
4431	0%	0%	100%	every game is tied
5445	10%	0%	90%	O only wins
8651	60%	40%	0%	Player O only wins via time → low average move per round of only 10.35 compare to 8655->39.6
8655	20%	0%	70%	both player have similar number of wins

Result:

- Most games are even but e1 has slightly better win percentage which was expected

Performance with different depths

Expectation: e1 ~e2, but player with higher depth wins more often

	e1 [%]	e2 [%]	
5441	50	0	Only O wins; 1 s restrictive for depth(X) = 6
8551	50	0	Only O wins; 1 s restrictive for depth(X) = 6
8555	15	0	Only O wins; more ties due to more time

Result:

- e2 is defensive → less ambition to win
- e1 is quicker: doesn't run into time constraint with higher depth

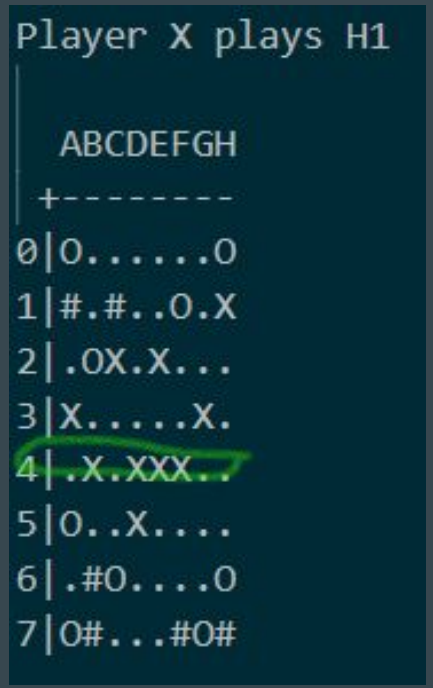
Performance with larger state spaces & short time

Expectation: time constraint → random moves → shorter games

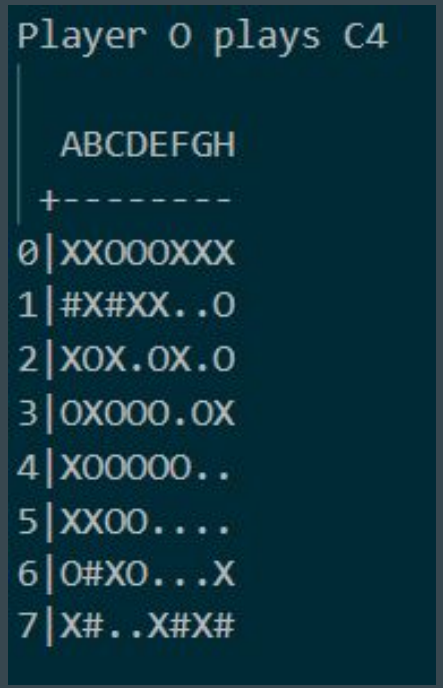
	e1 [%]	**e2 [%]**	average moves	
4431	0	0	12	well-balanced
5441	50	0	**16**	
5445	50	0	19	more time → better moves → longer games
8651	60	40	**10**	O only wins by time → low average moves
8655	100	0	40	not balanced, e2 recommends too defensive moves

Result: time constraint forces moves: e1 quicker/less affected → more wins

Performance with larger state spaces & short time



8655: time constraint



8655: board filled from A0 → H7 (depth reduction?)