AI – Assignment -2 Report

Tic-tac-toe

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Basic Introduction:

Basic Tic-Tac-Toe game is two player board game on 3X3 grid. Players take turns using symbols (X or O) on the grid to form a line of these three symbols horizontally, vertically, or diagonally. Game ends when a player win by forming a line on the grid. It is usually play among humans but it is interesting when a human play against a computer. In this case we train the computer using minimax algorithm and reinforcement learning algorithm to play the game.

Player : “O”

Computer : “X”

Terminal States values : +1 for win, -1 for lose and 0 for Draw

Minimax Algorithm:

Minimax algorithm is used in two player games. It is recursive and backtracking algorithm that give optimal move from the set of all possible moves given. It provides the most optimal move assuming that your opponent is playing optimally. The assigning of values based on the terminal state like +1 for win, -1 for lose and 0 for a draw. It only chooses the move that leads to the best possible outcome

Reinforcement:

Reinforcement learning is a powerful machine learning algorithm where an agent(player) learns to take decisions by learning from its environment. In this case, an agent is given some task, which interacts with the environment and make decisions based on the observation of the outcomes. We can set a learning rate (alpha) which determines how much the newly learned values overrides old value. It uses to control the speed of learning. The agent will get reward or penalty based on the respectively decisions taken. By training the model until it reach the certain saturation level, Over time agent will improve it’s decision making ability in order to get more rewards.

Comparative Analysis of Game Algorithms in Tic Tac Toe

The performance of each algorithm is evaluated based on the number of games won, lost, and drawn when the game is initiated by either the AI or a human player.

Total no. of game played = 10;

Algorithm	Game Started By AI/Human	Win	Lose	Draw	Remarks
Minimax	AI	7	0	3	Minimax algorithm performed better than Reinforcement Learning In both the cases. Minimax has higher rate of win and no chances to losses. On the other hand Reinforcement Learning algorithm has lower win rate as compared to Minimax. It is likely to win a game in RL when AI has the first turn.
Minimax	Human	5	0	5	
Reinforcement	AI	2	4	4	
Reinforcement	Human	1	3	6	

In Minimax:

We can **reduces the size of the json** file by using compression algorithms like gzip ,zlib and zip . They are effective for large json files.

Another is to remove the whitspaces and give shorter key names this will save lot space when we work with large json files.

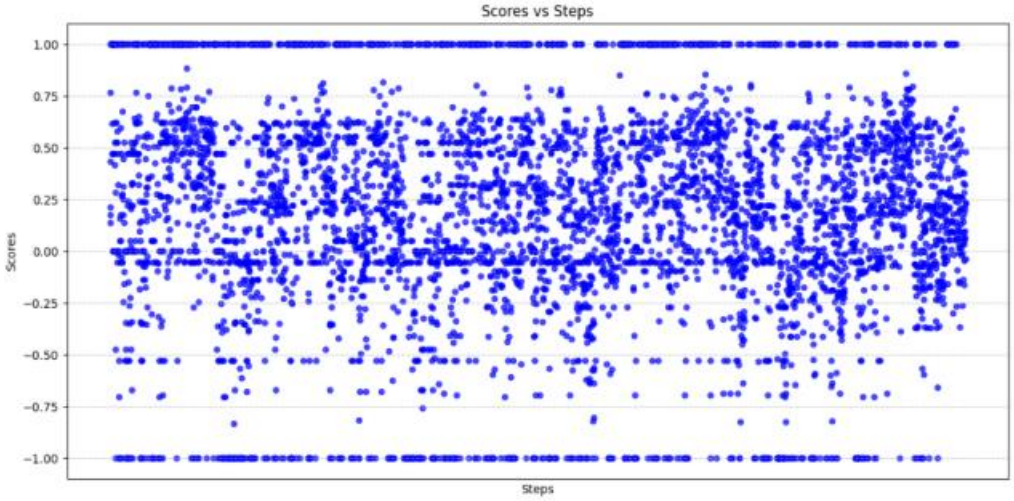
In Reinforcement Learning:

In the training context of the model I trained it on some different learning rate (alpha). Initially all the states have 0 value later after training they assigned with values.

Some experiments to see how the values of states differ when we change the learning rate or no. of iterations.

Case 1 :

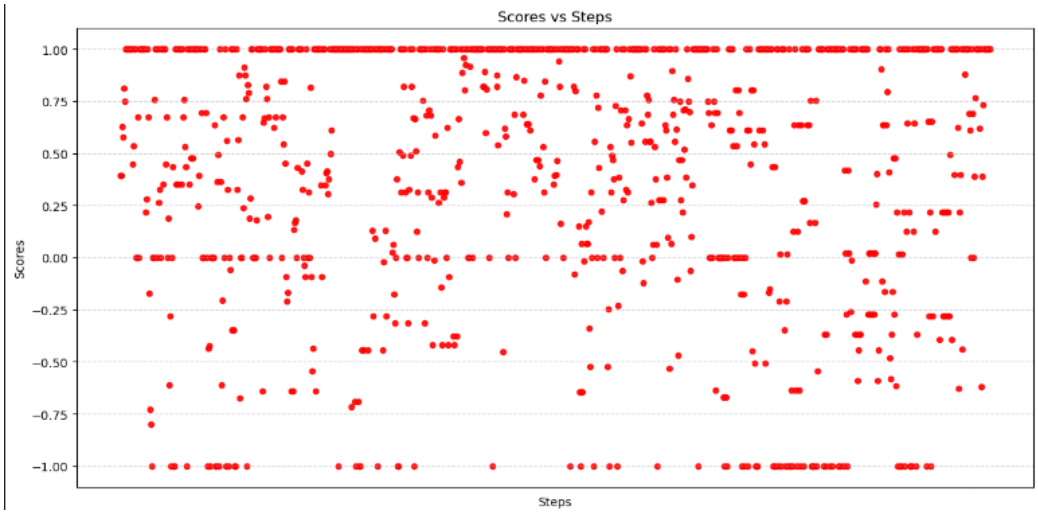
1. Learning Rate = 0.32
2. Iterations : 300



In case 1 , as we observe that our alpha is 0.32 and iterations is about 300 then the scattering of the score values of each states is dense

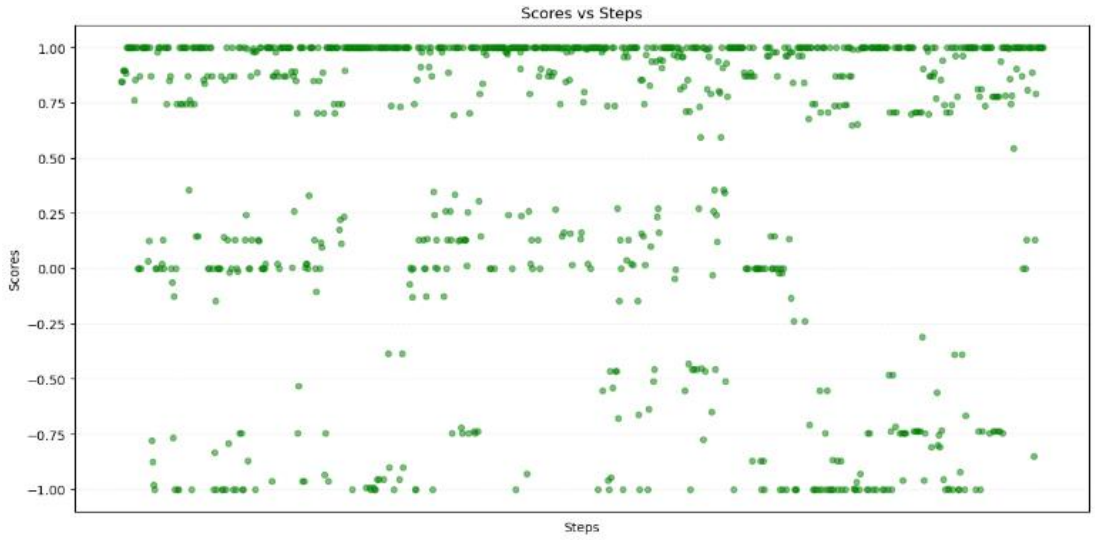
Case 2:

1. Learning rate = 0.85
2. Iterations = 800



Case 3 :

1. Learning rate = 0.62
2. Iterations = 1000



Observation:

In case 1 when the learning rate is less as well as no. of iterations . We can see that the values are dense to each other. In case 2 when increased the no. of iterations and learning rate values has been scatter more.

If we compare case 2 and case 3 we can see that there not much differ in both of the graph this because here we did enough no. of iteration that there is not so much differ in the states values from the values that they earlier they have.

Here we can stop training because after 1000 times of iterations there is very less changes occurring in the state values. In other words we can say it is the **saturation point** or near about it.

Efficacy of AI gameplay against a human player using the Minimax and Reinforcement Learning algorithms:

1. **Winning Rate**:
    - From 7 out of 10 times Minimax won the game .70% of the win happened when AI started the game. 50 % of games won when the game is started by human. Surprisingly there is none of the match won by human
    - In Reinforcement , 20 % of the game win happened when AI started the game. 10 % of games won when the game is started by human. There is more likely to draw and win the game as compared to Minimax
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Losing Rate:

- The Minimax algorithm did not loss any match, regardless who started the game.
- The Reinforcement Learning algorithm lost 40% of the games when started by the AI and 30% of the games when started by a human.

2. **Draw Rate**:
    - The Minimax algorithm drew 30% of the games when started by the AI and 50% of the games when started by a human.
    - The Reinforcement Learning algorithm drew 40% of the games when started by the AI and 60% of the games when started by a human

In conclusion, It is observed that Minimax algorithm has higher winning rate and very less losing rate as compared to the Reinforcement Learning algorithm, no matter who started the game. On the other hand Reinforcement learning algorithm has higher rate draw rate, especially the game is started by human . This suggests that while the Minimax algorithm is more likely to win, the Reinforcement Learning algorithm is more likely to avoid losing, making the game potentially more challenging and interesting for the human player.