CS561 - Assignment 3
Implementation of a simple game using Adversarial Search

Group Members
Jash Ratanghayra : 234101019
Kishan Hitendra Thakkar : 234101024

We are Implementing two games using Adversarial Search :

a. Tic Tac Toe(Minimax + Alpha-Beta Pruning)
b. Connect Four

1. Problem Definition

The problem involves implementing two classic board games, Tic Tac Toe and Connect Four, using adversarial search algorithms. Adversarial search is a technique used in artificial intelligence to make decisions in competitive environments where multiple agents have conflicting goals. In these games, the AI agent competes against a human player, aiming to either win the game or prevent the opponent from winning.

2. Input/Data Description

In both games, the input comprises the current state of the game board, represented as a grid where players place their pieces. The human player's moves are input through interactions with the game interface, while the AI agent's moves are determined algorithmically based on the current board state.

3. Solution Description / Implementation Details

3.1 Tic Tac Toe

- The implementation of Tic Tac Toe involves the utilisation of the Minimax algorithm, a decision-making technique commonly used in two-player games. This algorithm recursively explores the game tree, considering all possible moves and their resulting outcomes. In the context of Tic Tac Toe, the game tree is relatively small, allowing for efficient computation.

- The AI agent, representing the maximising player, seeks to choose moves that lead to the highest likelihood of winning or drawing the game. It assumes that the opponent, represented by the minimising player, also makes optimal moves.

- The implementation optionally incorporates Alpha-Beta Pruning, a technique used to reduce the number of nodes evaluated by the Minimax algorithm, thereby enhancing its efficiency. By pruning branches of the game tree that are unlikely to lead to a better outcome, Alpha-Beta Pruning significantly reduces the search space.

- The game interface provides a user-friendly platform for human-player interactions, allowing them to select their moves by specifying the cell in which they wish to place their mark (X or O). The AI agent's moves are then determined algorithmically, with the chosen move displayed on the game board.

3.2 Connect Four

- Connect Four follows a similar implementation approach to Tic Tac Toe, employing the Minimax algorithm with or without Alpha-Beta Pruning. However, due to the larger game board and increased complexity, the search space is significantly expanded.

- The objective of the AI agent in Connect Four is to strategically position its pieces on the board to form a horizontal, vertical, or diagonal line of four consecutive pieces before the opponent does. This requires the AI agent to not only consider its own potential winning moves but also anticipate and block the opponent's attempts.

- The game logic includes additional rules specific to Connect Four, such as the gravity rule, which causes pieces to fall to the lowest available position within a column when placed. The AI agent adapts its decision-making process to account for these rules, evaluating potential moves accordingly.

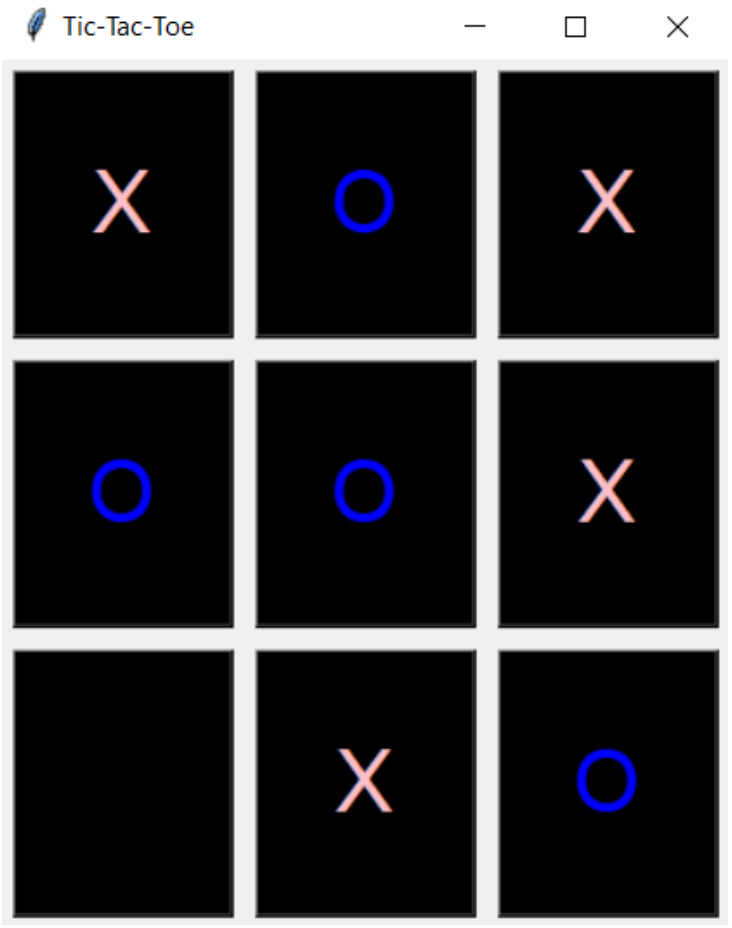
- Similar to Tic Tac Toe, the game interface allows human players to interact with the game board, selecting columns in which to drop their pieces. The

AI agent's moves are calculated algorithmically, with the chosen column displayed on the game board along with the resulting piece placement.

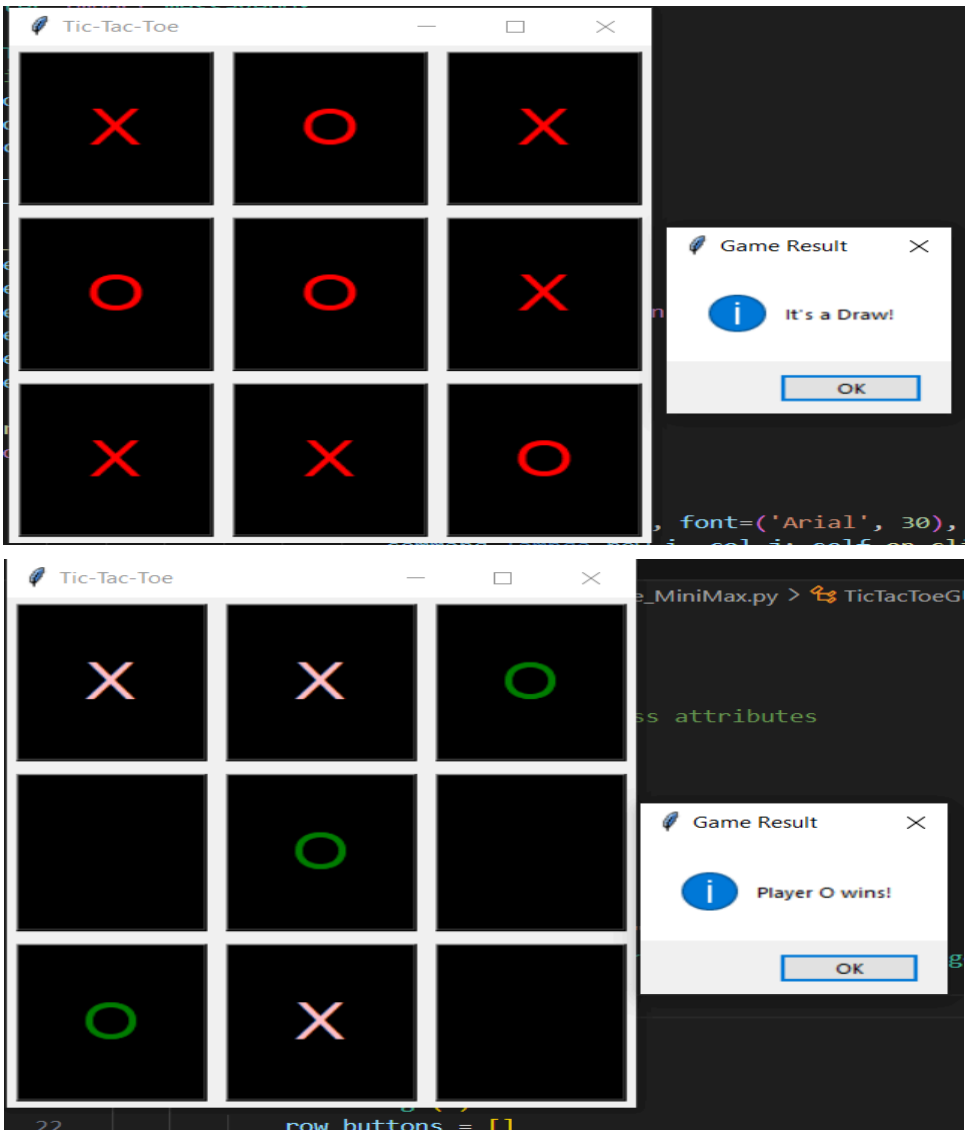
4. Output/Results

4.1 Tic Tac Toe

- The output of the Tic Tac Toe game includes the evolving state of the game board after each move, highlighting the positions of the X and O marks. Additionally, the game interface provides feedback on the outcome of the game, indicating whether the AI agent or the human player wins or if the game ends in a draw.



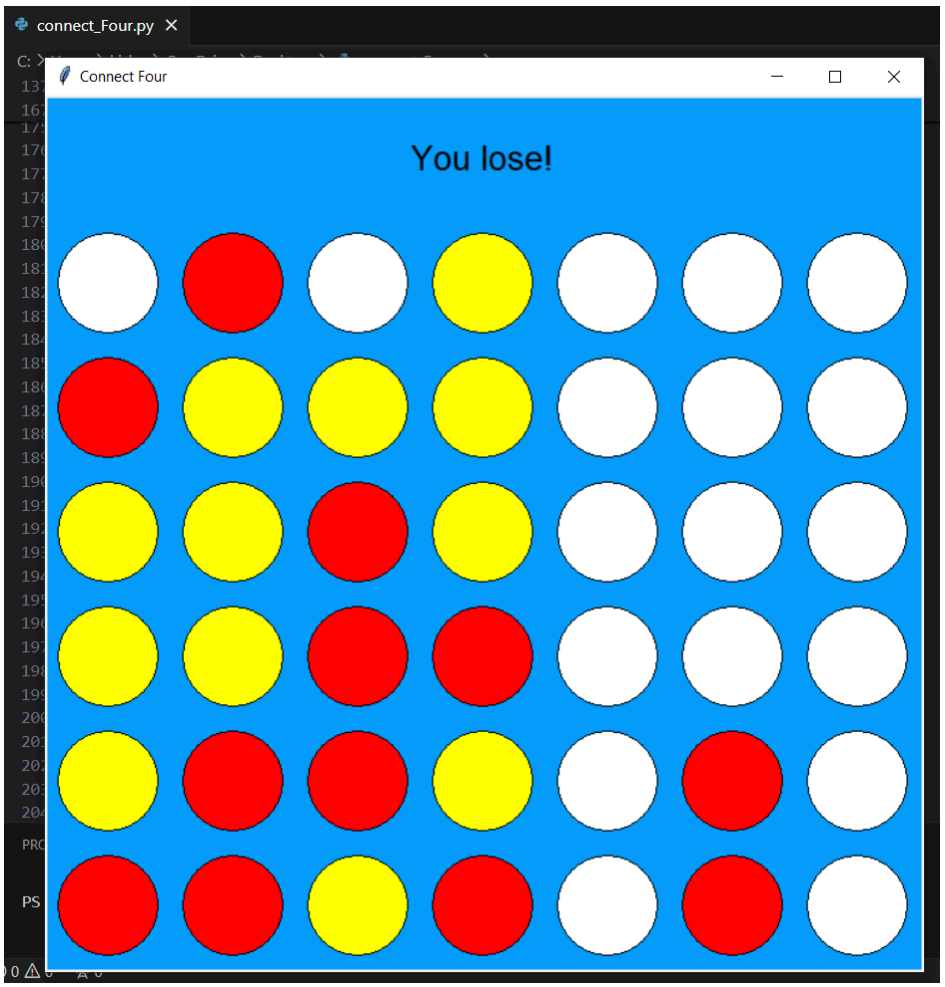
- Through the iterative gameplay experience, players observe the strategic decision-making of the AI agent, which aims to anticipate and counter the human player's moves while maximising its own chances of victory.



4.2 Connect Four:

- The AI agent engages in strategic gameplay against the human player, aiming to achieve victory by connecting four pieces while thwarting the opponent's attempts.

- The game interface showcases the progression of the game board, with the AI agent's moves strategically placed to advance its goal of winning.



5. References

- Russell, S. J., & Norvig, P. (2009). Artificial Intelligence: A Modern Approach (3rd ed.). Prentice Hall.

- https://medium.com/analytics-vidhya/minimax-algorithm-in-tic-tac-toe-adversarial-search-example-702c7c1030eb

- https://medium.com/analytics-vidhya/artificial-intelligence-at-play-connect-four-minimax-algorithm-explained-3b5fc32e4a4f