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# Artificial Intelligence

Laboratory 2

## Variant 1

Our code represents a simple command-line implementation of the classic Tic Tac Toe game using Python. The game is played between a player (represented by "X") and a computer (represented by "O"). The board is represented as a 3x3 matrix, where each cell of the matrix can be either empty or contain a player's move.
The main program is divided into several functions, including:

- draw_board(board): A function that takes the current board as input and prints it to the console in a visually pleasing format. The board is represented using Unicode characters to draw the border around the cells.
- is_valid_move(board, row, col): A function that takes the current board and a row and column position as input and returns whether the given move is valid (i.e., the cell is empty).
- make_move(board, row, col, player): A function that takes the current board, a row and column position, and the current player as input and makes the move on the board.
- is_game_over(board): A function that takes the current board as input and returns whether the game is over (i.e., either a player has won or the board is full).
- get_score(board): A function that takes the current board as input and returns the score for the board. The score is determined by checking if any player has won the game, with a score of 1 for the computer and -1 for the player if the computer wins, and a score of -1 for the computer and 1 for the player if the player wins. If there is no winner, the score is 0.
- get_best_move(board, depth, alpha, beta, player): A function that takes the current board, the depth of the search (i.e., the maximum number of moves ahead to consider), the alpha and beta values for alpha-beta pruning, and the current player as input and returns the best move and score for the given player. The function recursively searches through the game tree to find the best move for the player using the minimax algorithm with alpha-beta pruning.

  The Minimax algorithm is a recursive algorithm that searches through the game tree to find the optimal move for the computer player assuming that the human player will also make optimal moves. The algorithm computes the scores of each terminal state of the game and propagates them up to the root of the tree to make the best move. The score of a state is calculated by assuming that the computer is the maximizing player and the human is the minimizing player. In other words, the score is the maximum score that the computer can

achieve assuming optimal play by the human, or the minimum score that the human can achieve assuming optimal play by the computer.

The alpha-beta pruning is an optimization technique that prunes parts of the game tree that do not need to be explored because they cannot lead to a better solution than what has already been found. It does this by keeping track of two values, alpha and beta, which represent the minimum score that the maximizing player is assured of and the maximum score that the minimizing player is assured of, respectively. If the algorithm finds a move that leads to a score worse than the minimum value of alpha or better than the maximum value of beta, it prunes the rest of the subtree since it cannot be part of the optimal solution.

- play_game(): The main function that runs the game. It initializes the board, and then loops through each turn, alternating between the player and the computer. In each turn, it first draws the board, then prompts the player for their move if it's their turn, and makes the move if it's valid. If the game is over, it prints the final board and the result of the game.

Players take turns placing their symbol (X or O) on an empty space on the board, X goes first.

The game ends when one player gets three in a row (horizontally, vertically, or diagonally), or when all the spaces on the board are filled.

To make a move, you will be prompted to enter the row and column of the space you want to place your symbol in. Rows and columns are numbered from 1 to 3.

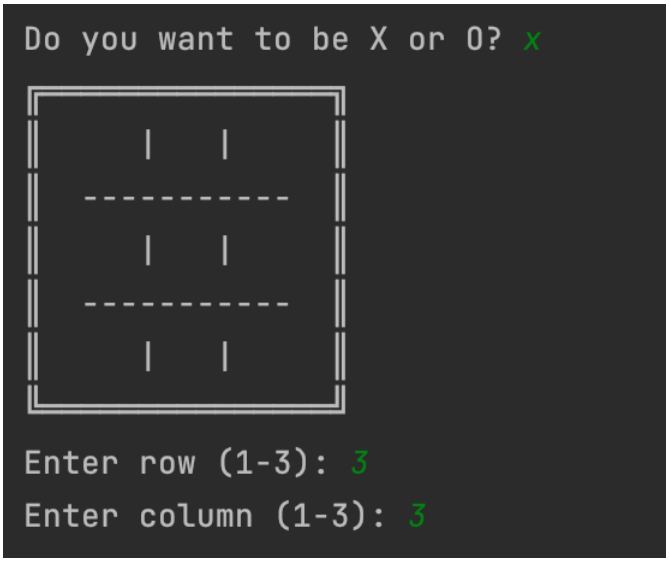
The computer will play as the second player (O), and will make its moves automatically.

The computer is not always making the smartest move because the get_best_move() function uses a minimax algorithm with alpha-beta pruning to search for the best move, but the depth of the search is limited to a fixed value of 3. This means that the computer will not be able to see more than 3 moves ahead, which can limit its ability to make the smartest move in some situations.

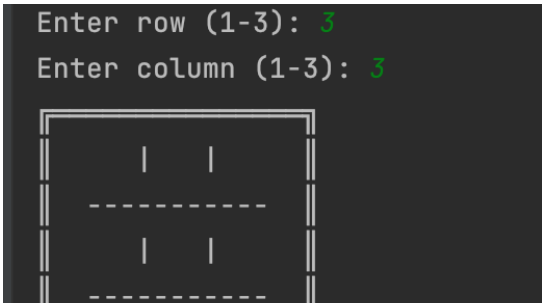
Additionally, the function also uses a heuristic score function that checks for wins and losses in the current board state, but it does not consider other factors that can affect the game, such as the placement of pieces on the board or potential future moves. This can also limit the computer's ability to make the smartest move.

Finally, the function randomly selects one of the best moves if there are multiple moves with the same score. This can sometimes result in the computer making a suboptimal move.

The game starts by asking the user if he want to play with (‘X’) or (‘O’). If the player chooses to be (‘X’) he plays first. The program displays an empty board and is asking for a player to choose a row and a column between 1-3:




After that the program prints the player’s move and after that it's the computer's turn to make a move.



The game continues until one of the players wins or the game is a tie.
Then it displays a message about the result before the program finishes.