ABSTRACT:

- Noughts and crosses strategy is very simple but stills allows users to gain an understanding of the basic approach to game playing. Also the game is solved so there is no excuse for not playing perfectly !

- Play against one of our Housebots or play against your own bots or your friends' bots. The aim of the game is to get three of your pieces, noughts "O" or crosses "X" in a line. Player's take turns adding one of their pieces to the grid, you can only add a piece to a blank position on the grid. The winner is the first to get three of their pieces in a line, if there are multiple deals in the Game Style being played then the winner is the player who has won the most games from the total number of deals.

- The game can be generalized to an m, n, k-game in which two players alternate placing stones of their own color on an *m*-by-*n* board with the goal of getting *k* of their own color in a row. Nought’s and crosses is the 3,3 ,3-game.Harary's generalized tic- tac-toe is an even broader generalization of tic-tac-toe. It can also be generalized as an n^d game, specifically one in which *n* equals 3 and *d* equals 2. It can be generalised even further by playing on an arbitrary incidence structure, where rows are lines and cells are points. Noughts and crosses incidence structure consists of nine points, three horizontal lines, three vertical lines, and two diagonal lines, with each line consisting of at least three points.

Adding intelligence to your bot :

- Once you are ready to start improving your bot you should draw your attention to the calculate_move() function, this is where all the action happens. This function is called every time the server wants you to make a move. It receives a dictionary of information containing the state of the game, namely the gamestate.

Code :

```
#!/usr/bin/env python3
from math import inf as infinity
from random import choice
import platform
import time
from os import system

"""
An implementation of Minimax AI Algorithm in Tic Tac Toe,
using Python.
"""

HUMAN = -1
COMP = +1
board = [
    [0, 0, 0],
    [0, 0, 0],
    [0, 0, 0],
]


def evaluate(state):
    """
    Function to heuristic evaluation of state.
    :param state: the state of the current board
    :return: +1 if the computer wins; -1 if the human wins; 0 draw
    """
    if wins(state, COMP):
        score = +1
    elif wins(state, HUMAN):
        score = -1
    else:
        score = 0

    return score


def wins(state, player):
    """
    This function tests if a specific player wins. Possibilities:
    * Three rows    [X X X] or [O O O]
    * Three cols    [X X X] or [O O O]
    * Two diagonals [X X X] or [O O O]
    :param state: the state of the current board
    :param player: a human or a computer
    :return: True if the player wins
    """
    win_state = [
        [state[0][0], state[0][1], state[0][2]],
        [state[1][0], state[1][1], state[1][2]],
        [state[2][0], state[2][1], state[2][2]],
        [state[0][0], state[1][0], state[2][0]],
        [state[0][1], state[1][1], state[2][1]],
        [state[0][2], state[1][2], state[2][2]],
        [state[0][0], state[1][1], state[2][2]],
        [state[2][0], state[1][1], state[0][2]],
    ]
    if [player, player, player] in win_state:
        return True
    else:
        return False


def game_over(state):
    """
    This function test if the human or computer wins
    :param state: the state of the current board
    :return: True if the human or computer wins
    """
    return wins(state, HUMAN) or wins(state, COMP)


def empty_cells(state):
    """
    Each empty cell will be added into cells' list
    :param state: the state of the current board
    :return: a list of empty cells
    """
    cells = []

    for x, row in enumerate(state):
        for y, cell in enumerate(row):
            if cell == 0:
                cells.append([x, y])

    return cells


def valid_move(x, y):
    """
    A move is valid if the chosen cell is empty
    :param x: X coordinate
    :param y: Y coordinate
    :return: True if the board[x][y] is empty
    """
    if [x, y] in empty_cells(board):
        return True
    else:
        return False


def set_move(x, y, player):
    """
    Set the move on board, if the coordinates are valid
    :param x: X coordinate
    :param y: Y coordinate
    :param player: the current player
    """
    if valid_move(x, y):
        board[x][y] = player
        return True
    else:
        return False


def minimax(state, depth, player):
    """
    AI function that choice the best move
    :param state: current state of the board
    :param depth: node index in the tree (0 <= depth <= 9),
    but never nine in this case (see iaturn() function)
    :param player: an human or a computer
    :return: a list with [the best row, best col, best score]
    """
    if player == COMP:
        best = [-1, -1, -infinity]
    else:
        best = [-1, -1, +infinity]

    if depth == 0 or game_over(state):
        score = evaluate(state)
        return [-1, -1, score]

    for cell in empty_cells(state):
        x, y = cell[0], cell[1]
        state[x][y] = player
        score = minimax(state, depth - 1, -player)
        state[x][y] = 0
        score[0], score[1] = x, y

        if player == COMP:
            if score[2] > best[2]:
                best = score  # max value
        else:
            if score[2] < best[2]:
                best = score  # min value

    return best
def clean():
    """
    Clears the console
    """
    os_name = platform.system().lower()
    if 'windows' in os_name:
        system('cls')
    else:
        system('clear')
def render(state, c_choice, h_choice):
    """
    Print the board on console
    :param state: current state of the board
    """
    chars = {
        -1: h_choice,
        +1: c_choice,
        0: ' '
    }
    str_line = '---------------'

    print('\n' + str_line)
    for row in state:
        for cell in row:
            symbol = chars[cell]
            print(f'| {symbol} |', end='')
        print('\n' + str_line)


def ai_turn(c_choice, h_choice):
    """
    It calls the minimax function if the depth < 9,
    else it choices a random coordinate.
    :param c_choice: computer's choice X or O
    :param h_choice: human's choice X or O
    :return:
    """
    depth = len(empty_cells(board))
    if depth == 0 or game_over(board):
        return

    clean()
    print(f'Computer turn [{c_choice}]')
    render(board, c_choice, h_choice)

    if depth == 9:
        x = choice([0, 1, 2])
        y = choice([0, 1, 2])
    else:
        move = minimax(board, depth, COMP)
        x, y = move[0], move[1]

    set_move(x, y, COMP)
    time.sleep(1)


def human_turn(c_choice, h_choice):
    """
    The Human plays choosing a valid move.
    :param c_choice: computer's choice X or O
    :param h choice: human's choice X or O
    :return:
    """
    depth = len(empty_cells(board))
    if depth == 0 or game_over(board):
        return

    # Dictionary of valid moves
    move = -1
    moves = {
        1: [0, 0], 2: [0, 1], 3: [0, 2],
        4: [1, 0], 5: [1, 1], 6: [1, 2],
        7: [2, 0], 8: [2, 1], 9: [2, 2],
    }

    clean()
    print(f'Human turn [{h_choice}]')
    render(board, c_choice, h_choice)

    while move < 1 or move > 9:
        try:
            move = int(input('Use numpad (1..9): '))
            coord = moves[move]
            can_move = set_move(coord[0], coord[1], HUMAN)

            if not can move:
                print('Bad move')
                move = -1
        except (EOFError, KeyboardInterrupt):
            print('Bye')
            exit()
        except (KeyError, ValueError):
            print('Bad choice')


def main():
    """
    Main function that calls all functions
    """
    clean()
    h_choice = ''  # X or O
    c_choice = ''  # X or O
    first = ''  # if human is the first
```

```python
    # Human chooses X or O to play
    while h_choice != 'O' and h_choice != 'X':
        try:
            print('')
            h_choice = input('Choose X or O\nChosen: ').upper()
        except (EOFError, KeyboardInterrupt):
            print('Bye')
            exit()
        except (KeyError, ValueError):
            print('Bad choice')

    # Setting computer's choice
    if h_choice == 'X':
        c_choice = 'O'
    else:
        c_choice = 'X'

    # Human may starts first
    clean()
    while first != 'Y' and first != 'N':
        try:
            first = input('First to start?[y/n]: ').upper()
        except (EOFError, KeyboardInterrupt):
            print('Bye')
            exit()
        except (KeyError, ValueError):
            print('Bad choice')

    # Main loop of this game
    while len(empty_cells(board)) > 0 and not game_over(board):
        if first == 'N':
            ai_turn(c_choice, h_choice)
            first = ''

        human_turn(c_choice, h_choice)
        ai_turn(c_choice, h_choice)

    # Game over message
    if wins(board, HUMAN):
        clean()
        print(f'Human turn [{h_choice}]')
        render(board, c_choice, h_choice)
        print('YOU WIN!')
    elif wins(board, COMP):
        clean()
        print(f'Computer turn [{c_choice}]')
        render(board, c_choice, h_choice)
        print('YOU LOSE!')
    else:
        clean()
        render(board, c_choice, h_choice)
        print('DRAW!')

    exit()


if __name__ == '__main__':
    main()
```