# Extreme Tic Tac Toe Bot

**Team:** TriBots (Team 25)
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## HEURISTIC

**Big Board**: Each of the 3X3 big board. So we have two big boards- Big Board 1 and Big Board 2
**Small Board**: Each 3X3 sub-matrix of a Big Board. Each Big Board has 9 Small Boards
**Cell:** A 1X1 box on the board. Each Small Board has 9 cells

We want to form winning patterns on the small boards as well as each big board. At the same time, certain cells are more advantageous to place our marker on as they contribute to more number of winning patterns. Hence, our heuristic is based on both pattern formation as well as which cells are occupied.

We will calculate the Heuristic by combining the score of the two Big Boards which in turn will be calculated by combining the scores of each Small Board of the Big Boards. The Score of each small board will be calculated based on the scores on individual cells and the patterns.

We will also take into account the patterns on the small boards as well as big boards and how much of a winning pattern is occupied by us and how much is occupied by the opponent.

**Cell Score:**

| | | |
|---|---|---|
| **3** | **2** | **3** |
| **2** | **4** | **2** |
| **3** | **2** | **3** |

cell_weight(i,j) is determined by number of winning patterns that include the position (i,j)

**Small Board Heuristic:**

- If we have won a small board, we assign it a large positive number
- If we have lost a board, we assign a negative value
- If there is a draw on any board, we assign it a value of 0
- For boards not under either of the above categories, we decide the score accordingly

    - Cell weightage: calculated based on cell_weight(i,j)
    - Patterns weightage: there are 8 winning patterns (3 rows, 3 columns, 2 diagonals)
        - If there is an opponent marker on a pattern, we do not consider that pattern (since we can't win by that pattern)
        - If we have occupied 2 cells of a winning pattern, we have a greater chance of winning that pattern, and assign it a positive value

**Big Board Heuristic:**

- For the big board heuristic, we consider patterns and positions of small boards
    - Small Board weightage: calculated based on small board heuristic and their relative positions in the Big Board (as per the cell_weightage calculated before)
    - Patterns weightage: again we have 8 winning patterns to win a big board and thus the game
        - If a small board is won by the opponent or drawn in a pattern, we do not consider it
        - If we have occupied 2 small boards of a pattern,  then it contributes more to the Big Board heuristic and thus, we assign those small boards a large positive value

**Total Heuristic:**

The total heuristic is calculated by combining the individual Big Board heuristics.

# SEARCH STRATEGY

1. Minimax Search with Alpha-Beta Pruning to find the best move
2. Iterative Deepening Search to progressively increase the search depth instead of fixing the depth to allow more levels of searching if the search returns values faster as branching factor decreases with depth and more number of heuristic values are stored in the hash table (since repeated states are encountered)
3. Search depth increased by 1 after every iteration and best move is updated accordingly
4. Search aborted after a specified amount of time to ensure enough time for remaining computations and make a move within 24 seconds