NATIONAL UNIVERSITY
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Project Title: Ultimate TicTacToe
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Course: AI
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1. Project Overview

● Project Topic:

The project is based on the enhanced version of classic Tic Tac Toe, known as Ultimate Tic Tac Toe. This version includes a 3x3 grid of 9 small 3x3 Tic Tac Toe boards, introducing depth and strategic complexity.

● Objective:

The main goal is to develop a strategic AI agent that can play Ultimate Tic Tac Toe competitively against a human player. The AI will use Minimax with Alpha-Beta Pruning, and heuristics which will be carefully designed to evaluate local and global board states. The project will focus on:

- Designing the full game mechanics
- Implementing a GUI for interactive play
- Integrating a decision-making AI opponent

2. Game Description

● Original Game Background:

TicTacToe is played on a single 3x3 grid where players alternate turns placing X and O on any of the 9 boxes , where the first player to get consecutive placements on either vertically , horizontally or diagonally part of the board wins the game .

● Innovations Introduced:

Ultimate Tic Tac Toe is played on a bigger 9-board (3x3 grid) where each board is a standard Tic Tac Toe. The position you play in a local board determines which board your opponent must play in next. Winning a local board gives control of that section on the global board, and the game is won by winning three local boards in a row.An intelligent agent should be developed which is capable of analyzing multiple game layers.A scoring system to evaluate both local and global boards.also forward-planning should be considered that makes the game more challenging for both human and AI.

3. AI Approach and Methodology

● AI Techniques to be Used:

Minimax Algorithm: For turn-based decision-making with lookahead to future game states.
Alpha-Beta Pruning: To optimize Minimax by eliminating branches that don't affect the outcome.
Depth-Limited Search: Limits how many moves ahead the AI considers to maintain performance.

● Heuristic Design:

The heuristic will be a combination of:

- Local Board Control: Points for owning or tying a small board.
- Potential Winning Paths: Points Awarded for controlling small boards in a row

Complexity Analysis:

Time Complexity: O(b^d), where b is the average branching factor and d is the depth. Due to the nested board structure, pruning and heuristics are essential to make real-time decisions.

Challenges:Managing and evaluating nested game states.Designing a heuristic that balances local wins with global strategy

4.Game Rules and Mechanics

● Modified Rules:

Players play on a 9 3x3 grid of 3x3 boards.

The cell starting player plays in determines the opponent's next board.

If that board is already won/full, the opponent can choose any board.

The move you make determines where your opponent must play next.if you play in the top right cell of a small board, your opponent must play in the top right small board on their next turn.

● Winning Conditions:

You win a small board by making 3 in a row.

You win by winning 3 small boards in a row.

If all boards are full with no clear winner, the game is a draw.

● Turn Sequence:

Players alternate turns.

The first player can play anywhere.

From the second move onward, the move location dictates the board for the opponent.

5. Implementation Plan

● Programming Language:

Python

● Libraries and Tools:

Pygame or Tkinter: For GUI and user interaction.

NumPy: For efficient data structures and game state management.

Custom-built AI Functions: For Minimax and heuristic evaluations.

● Milestones and Timeline:

○ Week 1-2: Game design and rule finalization

○ Week 3-4: AI strategy development (Minimax and heuristics)

○ Week 5-6: Coding and testing the game mechanics

○ Week 7: AI integration and testing

○ Week 8: Final testing and report preparation

6. References

https://en.wikipedia.org/wiki/Ultimate_tic-tac-toe