Medium Bot Logic and Complexity Analysis

3 Bytes

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1. Medium Bot Strategy

The Medium Bot follows a structured sequence of decisions:

1. **Immediate Win Check:** Attempt to place a piece in any column to achieve a winning configuration.
2. **Opponent Block:** Prevent the opponent from winning immediately by simulating their moves.
3. **Strategic Move Selection:** Choose a safe, center-preferred column that does not allow an immediate opponent win.
4. **Random Fallback:** Select a valid column randomly if no other move is available.

1.1 Function Overview

- **addValue(board, col, player):** Inserts a piece into the specified column. **Time complexity:** $O(\text{rows})$.
- **checkDirectionFrom(board, player, row, col, dRow, dCol):** Checks sequences of 4 pieces in a given direction. **Time complexity:** $O(1)$.
- **checkWin(board, player, lastRow, lastCol):** Checks four directions for a win from the last placed piece. **Time complexity:** $O(1)$.
- **wouldGiveOpponentWin(col):** Simulates a bot move and tests if the opponent could win immediately. **Time complexity:** $O(\text{cols} \cdot \text{rows})$.

2. Step-by-Step Complexity Analysis

1. **Immediate Win Check:** The bot evaluates each column for a winning move. Each evaluation involves placing a piece ($O(\text{rows})$) and checking for a win ($O(1)$). **Time complexity:** $O(\text{cols} \cdot \text{rows})$.

2. **Opponent Block:** The bot simulates each column as if the opponent placed a piece, then checks for a potential win. Each simulation is $O(\text{rows})$, with win checking $O(1)$ per column. **Time complexity:** $O(\text{cols} \cdot \text{rows})$.

3. **Strategic Move Selection:** The bot evaluates columns in a preferred order and uses `wouldGiveOpponentWin` to avoid risky moves. This involves, for each column:

   - Placing a piece: $O(\text{rows})$
   - Simulating all opponent moves: $O(\text{cols} \cdot \text{rows})$

   With cols columns, total complexity is:

   $$O(\text{cols} \cdot (\text{cols} \cdot \text{rows})) = O(\text{cols}^2 \cdot \text{rows})$$

4. **Random Fallback:** Chooses a random column and attempts placement. Worst-case complexity is $O(\text{rows})$.

3. Total Time Complexity

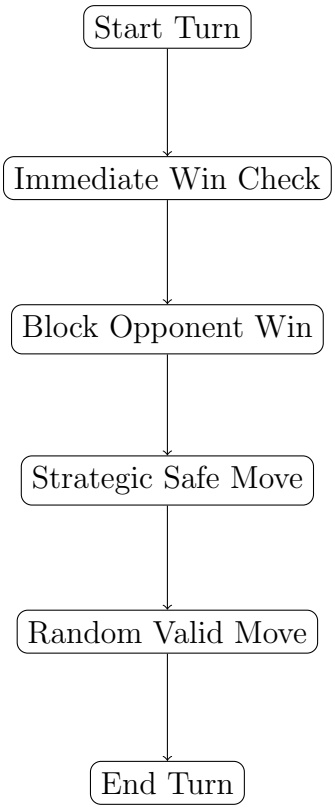
The strategic move selection dominates the overall complexity:

$$O(\text{cols}^2 \cdot \text{rows})$$

For the standard Connect Four board (6 rows $\times$ 7 columns), this evaluates to:

$$O(7^2 \cdot 6) = O(294)$$

4. Medium Bot Decision Flow



5. Summary

The Medium Bot evaluates potential moves in a prioritized sequence to maximize winning chances and prevent the opponent from winning. Each step's complexity is derived from the operations involved in simulating piece placements and checking for wins. The total worst-case complexity is $O(\text{cols}^2 \cdot \text{rows})$.