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AIES ASSIGNMENT 2

MINIMAX ALGORITHM – TICTACTOE

Code

```
#include <array>
#include <iostream>
#include <limits>

typedef std::array<std::array<char, 3>, 3> matrix;

void miniMax(matrix &gameBoard, char currentPlayer);
int maxValue(matrix &gameBoard);
int minValue(matrix &gameBoard);
bool checkFilledBoard(const matrix &gameBoard);
std::pair<char, bool> checkWinCondition(const matrix &gameBoard);

void miniMax(matrix &gameBoard, char currentPlayer) {
  int bestValue = (currentPlayer == 'X')
                      ? std::numeric_limits<int>::min()  // -2147483648
                      : std::numeric_limits<int>::max(); // 2147483647

  int bestMoveRow = -1, bestMoveCol = -1;

  // Traverse all cells to find the best move
  for (int i = 0; i < 3; i++) {
    for (int j = 0; j < 3; j++) {
      if (gameBoard[i][j] == '\0') {
        gameBoard[i][j] = currentPlayer; // Apply move X or O
        int moveValue =
            (currentPlayer == 'X') ? minValue(gameBoard) :
maxValue(gameBoard);
        gameBoard[i][j] = '\0'; // Reset

        // Choose the best move for X or O
        if ((currentPlayer == 'X' && moveValue > bestValue) ||
            (currentPlayer == 'O' && moveValue < bestValue)) {
          bestMoveRow = i;
          bestMoveCol = j;
          bestValue = moveValue;
```

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        }
      }
    }
  }

  // Apply the best move
  if (bestMoveRow != -1 && bestMoveCol != -1) {
    gameBoard[bestMoveRow][bestMoveCol] = currentPlayer;
    std::cout << "Best move for " << currentPlayer << ": (" << bestMoveRow
              << ", " << bestMoveCol << ")\n";
  }
}

// Maximizer
int maxValue(matrix &gameBoard) {
  auto [winner, isWin] = checkWinCondition(gameBoard);
  if (isWin) {
    if (winner == 'X')
      return 10;
    if (winner == 'O')
      return -10;
  }
  if (checkFilledBoard(gameBoard))
    return 0;

  int bestValue = std::numeric_limits<int>::min();
  for (int i = 0; i < 3; i++) {
    for (int j = 0; j < 3; j++) {
      if (gameBoard[i][j] == '\0') {
        gameBoard[i][j] = 'X'; // Maximizer's move
        bestValue = std::max(bestValue, minValue(gameBoard));
        gameBoard[i][j] = '\0'; // Undo the move
      }
    }
  }
  return bestValue;
}

// Minimizer
int minValue(matrix &gameBoard) {
  // returns a pair <char, bool>
  auto [winner, isWin] = checkWinCondition(gameBoard);
  if (isWin) {
    if (winner == 'X')
      return 10;
    if (winner == 'O')
      return -10;
  }
  if (checkFilledBoard(gameBoard))
    return 0;

  int bestValue = std::numeric_limits<int>::max();
  for (int i = 0; i < 3; i++) {
    for (int j = 0; j < 3; j++) {
      if (gameBoard[i][j] == '\0') {
        gameBoard[i][j] = 'O'; // Minimizer's move
        bestValue = std::min(bestValue, maxValue(gameBoard));
        gameBoard[i][j] = '\0'; // Undo the move
      }
    }
  }
  return bestValue;
}

// Function to check if the board is filled
bool checkFilledBoard(const matrix &gameBoard) {
  for (int i = 0; i < 3; i++) {
    for (int j = 0; j < 3; j++) {
      if (gameBoard[i][j] == '\0')
        return false;
    }
  }
  return true;
}

// Helper function to check if a line is complete
bool checkLine(const matrix &gameBoard, int x1, int y1, int x2, int y2, int
x3,
               int y3) {
  return gameBoard[x1][y1] == gameBoard[x2][y2] &&
         gameBoard[x1][y1] == gameBoard[x3][y3] && gameBoard[x1][y1] != '\0';
}

// Function to check if someone has won
std::pair<char, bool> checkWinCondition(const matrix &gameBoard) {
  // Check rows, columns, and diagonals
  if (checkLine(gameBoard, 0, 0, 0, 1, 0, 2))
    return {gameBoard[0][0], true};
  if (checkLine(gameBoard, 1, 0, 1, 1, 1, 2))
    return {gameBoard[1][0], true};
  if (checkLine(gameBoard, 2, 0, 2, 1, 2, 2))
    return {gameBoard[2][0], true};

  if (checkLine(gameBoard, 0, 0, 1, 0, 2, 0))
    return {gameBoard[0][0], true};
  if (checkLine(gameBoard, 0, 1, 1, 1, 2, 1))
```

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    return {gameBoard[0][1], true};
  if (checkLine(gameBoard, 0, 2, 1, 2, 2, 2))
    return {gameBoard[0][2], true};

  if (checkLine(gameBoard, 0, 0, 1, 1, 2, 2))
    return {gameBoard[0][0], true};
  if (checkLine(gameBoard, 0, 2, 1, 1, 2, 0))
    return {gameBoard[0][2], true};

  return {'\0', false};
}

int main() {
  matrix gameBoard{};
  bool gameEnded = false;
  char currentPlayer = 'X'; // First player X

  while (!gameEnded) {
    // Display the board
    std::cout << "Current board state:\n";
    for (int i = 0; i < 3; i++) {
      for (int j = 0; j < 3; j++) {
        std::cout << (gameBoard[i][j] == '\0' ? '-' : gameBoard[i][j]) << " ";
      }
      std::cout << std::endl;
    }

    miniMax(gameBoard, currentPlayer);

    // Check for a win condition
    auto [winner, isWin] = checkWinCondition(gameBoard);
    if (isWin) {
      std::cout << "Player " << winner << " wins!\n";
      gameEnded = true;
      break;
    }

    // Check for a draw
    if (checkFilledBoard(gameBoard)) {
      std::cout << "It's a draw!\n";
      gameEnded = true;
      break;
    }

    // Switch players: 'X' -> 'O', 'O' -> 'X'
    currentPlayer = (currentPlayer == 'X') ? 'O' : 'X';
  }
  return 0;
}
```
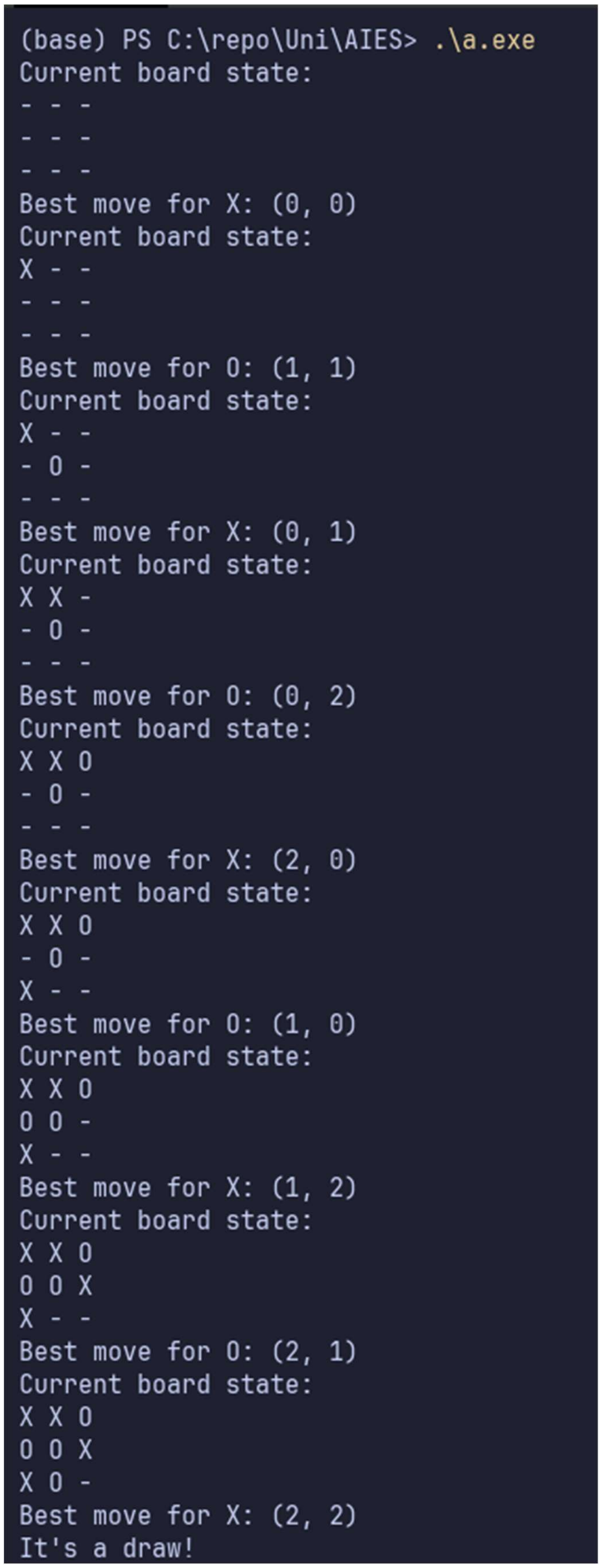

Output



```
(base) PS C:\repo\Uni\AIES> .\a.exe
Current board state:
- - -
- - -
- - -
Best move for X: (0, 0)
Current board state:
X - -
- - -
- - -
Best move for O: (1, 1)
Current board state:
X - -
- O -
- - -
Best move for X: (0, 1)
Current board state:
X X -
- O -
- - -
Best move for O: (0, 2)
Current board state:
X X O
- O -
- - -
Best move for X: (2, 0)
Current board state:
X X O
- O -
X - -
Best move for O: (1, 0)
Current board state:
X X O
O O -
X - -
Best move for X: (1, 2)
Current board state:
X X O
O O X
X - -
Best move for O: (2, 1)
Current board state:
X X O
O O X
X O -
Best move for X: (2, 2)
It's a draw!
```