Project Report: AI-Based Hex Game

Course: Artificial Intelligence

Submitted To: Miss Almas

# Team Members

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| Tahir Haider | 22k-6002 |
| Huzaifa Saleem | 22k-5103 |
| Lucky | 22k-5144 |

# 1. Project Overview

This project implements a playable Hex game with a basic AI opponent. The Hex game is a two-player strategy game played on a hexagonal grid, where players attempt to connect their respective sides of the board with an unbroken chain of pieces.

# 2. Objectives

- Develop a functional version of the Hex board game.

- Implement an AI using Minimax with Alpha-Beta Pruning for efficient move selection.

- Provide a visual interface for human vs AI gameplay.

- Create a playable and enjoyable game experience.

# 3. Tools and Technologies

- Programming Language: Python

- Libraries Used:

• numpy – for board management

• pygame – for graphical interface

• random – for move selection in non-AI scenarios

• custom minimax implementation – for AI with alpha-beta pruning

# 4. System Design

The game consists of two main components:

**4.1 Game Engine:**

Implements the core mechanics such as board creation, move validation, and win condition checking.

**4.2 AI Engine:**

Uses the Minimax algorithm enhanced with Alpha-Beta Pruning. This allows the AI to efficiently evaluate the best move by pruning unnecessary branches in the decision tree, significantly reducing computation time while maintaining optimal play.

# 5. Features

- Interactive graphical UI using pygame

- Human vs AI gameplay mode

- Real-time win checking

- Configurable board size

- AI powered by Minimax with Alpha-Beta Pruning

# 6. How It Works

1. Game starts by initializing the board.

2. Players alternate turns: human selects a cell, AI evaluates the best move using Minimax with Alpha-Beta Pruning.

3. After each move, win conditions are evaluated.

4. Game ends when one player successfully connects their assigned sides.

# 7. Results & Testing

The game was tested on various board sizes and works correctly. The AI performs competitively using alpha-beta pruning, enabling it to make strong moves while keeping computation efficient.

# 8. Future Work

- Further optimize the AI with heuristics

- Support online multiplayer

- Improve visual design and feedback

- Add user-selectable difficulty levels

# 9. Conclusion

The AI-Hex Game project demonstrates core game development principles in Python with an AI opponent powered by Minimax and Alpha-Beta Pruning. It serves as a solid base for both gameplay and AI learning extensions.