Project Title: *Connect Six - A Modified Connect Four Game*

Submitted By: *[Aina Bibi (22K-4655)], [Aymen Shakil (22K-4659)], [Warda Masood (22K-4433)]*
Course: *AI*
Instructor: *[Abdullah Yaqoob]*
Submission Date: *[10-March-2025]*

---

1. Project Overview

Project Topic:
*This project is a modified version of the classic Connect Four game, called **Connect Six**. The game follows similar mechanics but increases the challenge by requiring players to connect six pieces instead of four to win. This modification enhances the strategic depth and makes AI decision-making more complex.*

Objective:
*The goal of this project is to develop an AI player using the **Minimax algorithm** to play Connect Six optimally. The AI will evaluate board states and make strategic moves based on heuristic evaluations to maximize its chances of winning.*

---

2. Game Description

Original Game Background:
Connect Four is a two-player game played on a 7x6 grid where players take turns dropping discs into columns. The first player to connect four of their discs in a row, column, or diagonal wins.

Innovations Introduced:

- ***Winning Condition Change:*** *Instead of connecting four, a player must connect **six** discs to win.*
- ***Strategic Complexity:*** *The requirement to connect six discs extends the game duration and increases the difficulty of winning, making AI planning more crucial.*
- ***Board Size Consideration:*** *The game might use a larger board (e.g., 8x9) to accommodate the new rule while maintaining fairness and excitement.*

These modifications impact gameplay by requiring players (and the AI) to plan longer-term *strategies rather than focusing on short-term connections.*

---

3. AI Approach and Methodology

AI Techniques to be Used:

- ***Minimax Algorithm:*** *The AI will evaluate possible moves by simulating opponent responses and selecting the best possible action.*
- ***Alpha-Beta Pruning:*** *This optimization will reduce the number of nodes explored, improving performance.*
- ***Heuristic Evaluation:*** *The AI will use a scoring system to evaluate board positions and determine optimal moves.*

Heuristic Design:

- *Assign scores based on potential sequences of six connected pieces.*
- *Consider blocking opponent's sequences.*
- *Evaluate central row control for long-term advantages.*

Complexity Analysis:

- *The time complexity of standard Minimax is **O(b^d)**, where **b** is the branching factor and **d** is the depth.*
- *Alpha-Beta pruning will help reduce the number of nodes evaluated, making the AI more efficient.*

---

4. Game Rules and Mechanics

Modified Rules:

- *Players take turns dropping pieces into a **row** instead of a column.*
- *The objective is to connect **six** pieces instead of four.*
- *The game may be played on a **larger grid (e.g., 8x9)** to balance the extended win condition.*

Winning Conditions:

- *A player wins by forming a horizontal, vertical, or diagonal line of six consecutive pieces.*

Turn Sequence:

- *Players alternate turns.*
- *Each turn, a player drops one piece into a row.*
- *The AI follows the Minimax decision-making process before placing its piece.*

---

5. Implementation Plan

Programming Language: *Python*

Libraries and Tools:

- ***NumPy*** *(for board representation and calculations)*
- ***Other AI Libraries*** *(if needed, e.g., for additional optimizations)*

Milestones and Timeline:

- ***Week 1-2:*** *Finalize game rules and board setup.*
- ***Week 3-4:*** *Implement Minimax and Alpha-Beta pruning.*
- ***Week 5-6:*** *Develop GUI and integrate game mechanics.*
- ***Week 7:*** *Test AI performance and adjust heuristics.*
- ***Week 8:*** *Final debugging, optimizations, and report preparation.*

---

6. References

- *Research papers on Minimax and Alpha-Beta pruning in board games.*
- *Articles and tutorials on AI implementation for Connect Four.*
- *Documentation for Pygame and NumPy.*
