Project Proposal

Project Title: *Nine Men's Morris*
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Course: AI-Lab
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1. Project Overview

- **Project Topic:**
  This project will enhance the traditional Nine Men's Morris by introducing Time Bombs, an Undo feature, and an AI opponent using Minimax with Alpha-Beta pruning. These additions aim to modernize the gameplay and provide a challenging single-player experience.
- **Objective:**
  To develop a modified version of Nine Men's Morris featuring new rules, and to implement an AI that plays strategically using classical game tree search techniques.

2. Game Description

- **Original Game Background:**
  Nine Men's Morris is a strategic board game that involves placing, moving, and capturing pieces with the goal of reducing the opponent's pieces to less than three. The game consists of three phases:
  - *Placement Phase: Players take turns placing pieces on the board.*
  - *Movement Phase: Players move pieces to adjacent positions.*
  - *Flying Phase: If a player has three pieces remaining, they can move freely across the board.*

  The objective is to form a "mill" (three pieces in a row) to remove the opponent's pieces. The game uses adversarial AI to play against the user.
- **Innovations Introduced:**
  - ***Strategic AI:*** *The AI evaluates where to place a piece, and to use a bomb, prioritizing high-impact placements.*
  - ***Time Bombs:*** *Each player can place a single bomb on their own piece. After 3 turns, it detonates, destroying all adjacent pieces.*
  - ***Undo Feature:*** *The player may undo up to three times in the game.*

3. AI Approach and Methodology

- **AI Techniques to be Used:**
  - *Minimax Algorithm with Alpha-Beta Pruning for efficient move search*
  - *Heuristic-based evaluation of board states*
  - *Rule-based bomb placement logic*
- **Heuristic Design:**

  The AI scores states based on:
  - Piece difference
  - Formed and near-formed mills
  - Mobility and blocking potential
  - Game phase (placing, moving, flying)
- **Complexity Analysis:**

  Using Alpha-Beta pruning reduces search depth complexity. Bomb effects are handled outside the search tree, simplifying evaluation.

4. Game Rules and Mechanics

- **Modified Rules:**
  - *Each player can place one Time Bomb on their own piece*
  - *Bombs detonate after 3 of the owner's turns and destroy adjacent pieces*
  - *Undo feature: The player can undo up to 3 moves*
  - *Bombed pieces return to the placement pool if destroyed*
- **Winning Conditions:**
  - *A player loses if they have fewer than 3 pieces after placing is done or if they cannot make a valid move. The opponent is then declared the winner.*
- **Turn Sequence:**
  - *Players alternate turns.*
  - *On each turn, they can place, move, fly according to the different phases of the game, or use a bomb.*
  - *Bombs tick down at the start of the player's turn.*
  - *Detonations and undo actions are handled before the next player acts.*

5. Implementation Plan

- **Programming Language:** *Python*
- **Libraries and Tools:**
  - *Libraries: Standard Python libraries (time, random, os)*
  - *Tools: GitHub for version control*

- **Milestones and Timeline:**
  - **Week 1–2:** Rule design and board setup
  - **Week 3–4:** AI (Minimax + Alpha-Beta)
  - **Week 5–6:** Bomb & Undo features
  - **Week 7–8:** Testing and documentation

6. Team Members

- Ahmad Ali Ansari (22K-4385)
- Rafay Ahmad (22K-4462)
- Muhammad Hassaan (22K-4404)

7. References

- *Nine Men's Morris game rules and history – Wikipedia*
- *Minimax and Alpha-Beta Pruning tutorials* – GeeksforGeeks
- *Python documentation* – https://docs.python.org/3/
- *GitHub for version control* – https://github.com/