**AI Project Proposal**

**Project Title:** Strategic Snakes & Ladders: A Turn-Based Risk Management AI Game  
**Submitted By:** Shaheer Ahmed Qidwai

**Team Members:**   
Shaheer Ahmed 22k-4541  
Atif Arif 22k-4358  
Abdul Rafay 22k-4517

**Course:** AI  
**Instructor:** Miss Alishba Subhani  
**Submission Date:** 15th April 2025

### **1. Project Overview**

**Project Topic:**This project Modifies the classic board game Snakes & Ladders by introducing strategic elements that enable players to influence game outcomes through decision-making, rather than relying solely on chance. Key innovations include trap placements, power-up tiles, and multi-path navigation.

**Objective:**To develop an AI capable of making optimal decisions in a modified Snakes & Ladders environment using the Minimax algorithm with Alpha-Beta Pruning. The AI will assess risk, evaluate potential gains, and plan strategically within the custom rule set.

### **2. Game Description**

**Original Game Background:**Snakes & Ladders is a race game played on a grid-based board. Players roll dice to move forward. Ladders advance the player upwards, while snakes send them backward. The first to reach the final tile wins.

**Innovations Introduced:**

* **Trap Placement:** Each player gets one trap they can deploy on the board to convert a ladder into a snake or vice versa.
* **Power-Up Tiles:** Landing on certain tiles grants strategic power-ups such as immunity from traps, swapping positions with another player, or skipping a snake. (This implementation of tiles may be transformed to wild cards at random turns at later stage of development)
* **Multi-Path Design:** The board includes forked paths, allowing players to choose between safe but long routes and risky shortcuts. And there would be snakes at each path which might get a player to another more dangerous path.

These innovations add layers of strategic thinking, allowing the AI to analyze outcomes beyond linear movement.

### **3. AI Approach and Methodology**

**AI Techniques to be Used:**

* **Minimax Algorithm:** Modified for two or more players, used to simulate possible game states.
* **Alpha-Beta Pruning:** Implemented to optimize the game tree search and reduce computational overhead.
* **Monte Carlo Simulations:** To estimate win probabilities and simulate uncertain future states based on power-up usage or path choices.

**Heuristic Design:**

* Estimated distance to goal (normalized position).
* Penalty risk (likelihood of landing on a snake or trap).
* Power-up utility score.
* Positional advantage over opponents.

**Complexity Analysis:**

* **Time Complexity:** Increased due to multi-player branching and strategic options.
* **Challenges:** Managing large state spaces due to traps, power-ups, and path choices; ensuring efficient pruning and state evaluation.

### **4. Game Rules and Mechanics**

**Modified Rules:**

* Each player may place one or more traps per game.
* Power-up tiles appear at fixed locations. this can be implemented in the form of random cards per game as well, which gives certain powerups to the players.
* Players choose between multiple paths at certain junctions.

**Winning Conditions:**

* First player to reach or pass the final tile wins.

**Turn Sequence:**

* Players take turns sequentially. On each turn, they may roll and choose actions such as using a power-up, selecting a path, or placing a trap (if available).

### **5. Implementation Plan**

**Programming Language:** Python

**Libraries and Tools:**

* **Pygame:** For GUI visualization (GUI visualisation is considered as an optional yet important aspect of the project).
* **NumPy:** For efficient data handling and matrix operations.
* **No external AI libraries** required; AI logic implemented manually.

**Milestones and Timeline:**

* **Week 1-2:** Design board and finalize rules.
* **Week 3-4:** Implement core AI strategy (Minimax + heuristics).
* **Week 5-6:** Code game mechanics and interactions.
* **Week 7:** Integrate AI agent and conduct test runs.
* **Week 8:** Final testing and documentation/report writing.

### **6. References**

* Classic Snakes & Ladders rules
* [AI: A Modern Approach] by Russell & Norvig
* Online resources on Minimax, Alpha-Beta pruning, and game tree evaluation