Project Title: Spiral Snakes & Ladders: A Multi-Ring AI Adaptation

Submitted By:

- 22K-4173 Ibrahim Abdullah
- 22K-4471 Muhammad Ashar
- 22K-4625 Sayal Baig

Course: Artificial Intelligence
Instructor: Talha Shahid
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1. **Project Overview**

- **Project Topic:**
  Development of an AI player for "Spiral Snakes & Ladders", an innovative 3D-printed-board-inspired variant featuring concentric circular rings with dynamic path manipulation.
- **Objective:**
  To create:
  - A modified expectimax algorithm adapting to the spiral board geometry
  - Novel heuristics evaluating ring progression and risk-reward of path modifiers
  - A Pygame visualization demonstrating AI decision-making

2. **Game Description**

- **Original Game Background:**
  Traditional Snakes and Ladders is a luck-based race game where players climb ladders (rewards) and slide down snakes (penalties).
- **Innovations Introduced:**
  Multi-Ring Spiral Board: 3 concentric rings (0=center, 1=middle, 2=outer) with 10 tiles each
- **Dynamic Path Modifiers:**
  - Ascending Ladders: Move inward (lower ring numbers)
  - Descending Snakes: Move outward
- **Strategic Movement:** Players choose clockwise/counter-clockwise direction each turn

3. **AI Approach and Methodology**

- **AI Techniques:**
  - Expectimax Algorithm (Adapted for directional choice)
  - Heuristic Hybridization combines:
    - Ring proximity to center (50 × (3 - ring))
    - Ladder attraction ((10-distance)×3)
    - Snake avoidance ((10-distance)×5)
- **Complexity Analysis:**
  - Branching factor: 2 directions × 6 dice outcomes = 12 (MAX)
  - State space: 3 rings × 10 tiles = 30 positions
  - Heuristic computation: O(n) per evaluation (n = path modifiers)

4. **Game Rules and Mechanics**

- **Modified Rules:**
  - Players start at (2,0) - outermost ring
  - MAX (AI) rolls 1-6, MIN (adversary) rolls 1-3
  - Direction choice (CW/CCW) becomes strategic decision
- **Winning Condition:**
  - First to reach (0,0) - center tile within 10 turns
- **Turn Sequence:**
  - MAX chooses direction → rolls die → moves
  - MIN chooses direction → rolls die → moves
  - Repeat until win or turn limit

5. **Implementation Plan**

- **Programming Language:** Python
- **Libraries/Tools:**
  - Pygame (Interactive visualization)
- **Milestones and Timeline:**
  - Week 1-2: Board geometry implementation
  - Week 3-4: Core game mechanics + rules
  - Week 5-6: Expectimax with spiral heuristics
  - Week 7: Adversarial AI integration
  - Week 8: GUI polish + performance testing

6. **References**

- Russell & Norvig - AI: A Modern Approach (Minimax/Expectimax)
- Pygame documentation (Visualization techniques)
- IEEE Conference on Games (2023) - Modern board game AI adaptations