National University Of Computer and Emerging Sciences Karachi Campus

Project title:

Ludo 2.0 – A Smart, Tactical Twist on the Classic Game

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1. Project Overview

Project Topic:

Ludo 2.0 – reimagines the classic board game by integrating a strategy-based point system alongside traditional dice roll. Players earn strategy points that allow them to influence dice outcomes, introducing a layer of tactical decision-making. An AI opponent predicts optimal moves and adapts to player behavior, enhancing the challenge and competitiveness of the game.

Objectives:

1. Enhance player engagement through a point-based system for dice control.
2. Implement an adaptive AI that predicts and adjusts to player strategies.
3. Balance luck and skill to cater to both casual and competitive players.
4. Increase replayability by offering dynamic AI and new mechanics.

2. Game Description

Original Game Background:

Ludo is a classic turn-based board game where players roll a six-sided die to move their four tokens from the starting position to the home area. The game primarily relies on luck, as dice rolls determine movement. Players can capture opponents' pieces, sending them back to the starting area, adding a strategic element to an otherwise chance-based game.

Innovations Introduced:

- Strategy Points System: Players earn points that can be used to modify dice rolls strategically.
- AI Opponent: An intelligent AI adapts to player decisions and predicts moves.
- Dynamic Game Mechanics: Introduces skill-based elements while maintaining Ludo's core gameplay.
- Balanced Gameplay: Players can choose between spending points on better rolls or saving them for critical moments.
- Multi-Agent AI: The AI will use heuristic-based decision-making to counter human strategies.

3. AI Approach and Methodology

AI Techniques to be Used:

Minimax Algorithm: Modified for multi-player settings to simulate strategic moves.
Alpha-Beta Pruning: Optimizes AI decision-making to reduce unnecessary computations.
Heuristic-Based Decision Making: AI evaluates the best dice manipulation strategies.
Reinforcement Learning: AI may learn from past moves to improve gameplay.

Heuristic Design:

- Evaluating risk vs. reward in using strategy points.
- Predicting opponent movements and potential captures
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Complexity Analysis:

- The introduction of decision-making increases the computational complexity compared to classic Ludo.
- AI heuristics must efficiently evaluate multiple player choices while maintaining game speed.

4. Game Rules and Mechanics

Modified Rules:

- Players earn strategy points at specific game events (e.g., reaching checkpoints, eliminating opponents).
- Instead of pure random rolls, players can spend points to reroll or adjust dice values within a limit.
- AI dynamically adjusts difficulty based on player performance.

Winning Conditions:

- A player wins by moving all their tokens into the home area.
- Players must strategize point usage to optimize movement while countering AI or opponents.

5. Implementation Plan

Programming Language:

- Python

Libraries and Tools:

- **Pygame** (for GUI)
- **NumPy** (for AI Computation)
- **Scikit-learn/TensorFlow** (For reinforcement learning)

Milestones and Timeline:

- **Week 1-2:** Game design and rule finalization
- **Week 3-4:** AI strategy development (Minimax and heuristics)
- **Week 5-6:** Coding and testing the game mechanics
- **Week 7:** AI integration and testing
- **Week 8:** Final testing and report preparation