Project Title: AI-Enhanced Sudoku
Submitted By: 21i-2957 Muhammad Wajih Hyder, 21k-3379 Abdul Ali Ahmed
Course: AI
Instructor: Abdullah Yaqoob
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1. Project Overview

- **Project Topic:**
  This project aims to develop an innovative version of Sudoku called "Dynamic Sudoku," where the puzzle grid evolves dynamically as players solve it. The game will introduce new mechanics, such as shifting numbers and power-ups.

- **Objective:**
  The main goal of this project is to create an AI-powered Sudoku solver that can generate, adapt, and solve puzzles. The AI will use constraint satisfaction techniques, reinforcement learning, and neural networks to create engaging and challenging puzzles for players.

2. Game Description

- **Original Game Background:**
  Sudoku is a logic-based number placement game played on a 9x9 grid.
  The goal is to fill each row, column, and 3x3 sub-grid with digits 1-9
  without repetition.
- **Innovations Introduced:**
  - *Dynamic Grid Adjustments: Some numbers change positions at set intervals, increasing difficulty.*
  - *Power-Ups: Players can use special moves such as "Reveal a Number" or "Freeze a Cell."*
  - *AI-Generated Puzzles: The AI creates puzzles that adapt based on player performance.*

3. AI Approach and Methodology

- **AI Techniques to be Used:**

    - *Constraint Satisfaction Problem (CSP) Solver: AI will use CSP techniques to generate and validate puzzles.*
    - *Genetic Algorithms: To evolve increasingly complex puzzle designs.*
    - *Reinforcement Learning: AI adapts difficulty dynamically based on player performance.*
- **Heuristic Design:**
    - *Cell difficulty will be based on placement constraints and prior solutions.*
    - *AI will track player patterns to adjust puzzle complexity in real-time.*
    - *Dynamic scoring based on the number of hints used and time taken.*

- **Complexity Analysis:**
    - *Generating and solving Sudoku dynamically requires balancing CSP techniques with reinforcement learning.*
    - *AI will need efficient algorithms to adjust puzzles without making them unsolvable.*

4. Game Rules and Mechanics

- **Modified Rules:**
    - *Some numbers will shift dynamically after a set number of moves.*
    - *Players can use power-ups like hints, freezing cells, or undoing previous moves.*
- **Winning Conditions:**
    - *The player wins by solving the puzzle within the time limit with minimal errors.*
- **Turn Sequence:**
    - *After every 5 correct guesses, the already solved numbers on the board will shift to different positions. The player can use power ups like freeze or reveal, but they will be limited. Score will be calculated based on time taken and powers used.*

5. Implementation Plan

- **Programming Language:** *Python*
- **Libraries and Tools:**
    - *Pygame*

    - *NumPy*
    - *TensorFlow/PyTorch (for AI difficulty adaptation)*
- **Milestones and Timeline:**
    - **Week 1-2:** Game design and rule finalization
    - **Week 3-4:** AI puzzle generation and solving techniques
    - **Week 5-6:** Implementing dynamic grid mechanics
    - **Week 7:** Power-up integration
    - **Week 8:** Final testing and report preparation