Project Title: Sequence Game (Ai Based)

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1. Project Overview

Project Topic:

The project aims to develop an AI-powered version of *Sequence*, a strategy-based board and card game that combines elements of *Connect Four* and *Poker*. Players place chips on a board corresponding to cards played from their hands, aiming to form sequences of five in a row. The AI will implement advanced decision-making strategies for both single-player and multiplayer modes.

Objective:

The main goal is to develop a strategic AI capable of playing *Sequence* efficiently. The AI will employ the **Minimax algorithm** with optimizations like **Alpha-Beta Pruning** to make intelligent decisions. The project will also explore **heuristic evaluations** for different game states, ensuring competitive and challenging gameplay.

2. Game Description

Original Game Background:

Sequence is a board game played with a standard deck of playing cards. Players take turns playing a card from their hand and placing a chip on the corresponding space on the board. The objective is to form sequences (five chips in a row, horizontally, vertically, or diagonally). The game can be played in teams or individually. Jacks act as wildcards, allowing flexibility in placement.

Innovations Introduced:

- **AI Opponent:** Implementation of an AI player capable of making strategic decisions using **Minimax** and **heuristic evaluation**.
- **Game Variations:** New board layouts and rule variations to increase strategic complexity.
- **Adaptive Difficulty:** AI difficulty levels that adjust based on the player's skill level.

- **Online Multiplayer (Optional):** Implementation of a multiplayer feature allowing users to play against each other remotely.

3. AI Approach and Methodology

AI Techniques to be Used:

- **Minimax Algorithm:** Used to evaluate the best possible move by simulating different future scenarios.
- **Alpha-Beta Pruning:** Optimization technique to improve the efficiency of Minimax by eliminating unnecessary calculations.
- **Heuristic Evaluation:** The AI will assess board positions based on factors like potential sequences, blocking moves, and available plays.
- **Reinforcement Learning (Optional):** To enhance AI performance over time through self-play training.

Heuristic Design:

- Assign scores based on **sequence formation probabilities**.
- Detect **opponent threats** and prioritize defensive moves.
- Evaluate **board control** and positioning advantages.

Complexity Analysis:

- The state space of *Sequence* is large, making brute-force search infeasible.
- Minimax with Alpha-Beta Pruning will help reduce computation time.
- Heuristic evaluation will further refine move selection to balance accuracy and efficiency.

4. Game Rules and Mechanics

Modified Rules:

- Introduction of **AI difficulty levels**.
- New **board layouts** and modified wildcard rules to enhance strategy.
- Optional **timer** for turn-based play.

Winning Conditions:

- A player wins by forming **two sequences of five in a row** (standard rule).
- In custom variations, different winning conditions may apply.

Turn Sequence:

- Players take turns **playing a card** and **placing a chip** on the corresponding board space.
- AI follows **strategic decision-making** based on game state evaluation.
- Turns continue until a player achieves the **winning condition**.

5. Implementation Plan

Programming Language:

- **Python** (for AI logic and backend).
- **Flutter** (for mobile UI) or **Web-based frontend** (React, JavaScript, or HTML/CSS).

Libraries and Tools:

- **Python:** NumPy, Flask (for backend API), PyTorch (optional for RL).
- **Flutter:** Dart (for UI development).
- **Web:** React.js, WebSockets (for real-time play).

Milestones and Timeline:

Week	Task
1-2	Game rule finalization and initial design.
3-4	AI strategy development (Minimax, heuristic tuning).
5-6	Coding and testing game mechanics.
7	AI integration and debugging.
8	Final testing, optimizations, and report preparation.

6. References

- Ultra Board Games – Sequence Rules (UltraBoardGames - Sequence Rules).
- Game-Rules (GameRules - How to Play Sequence).