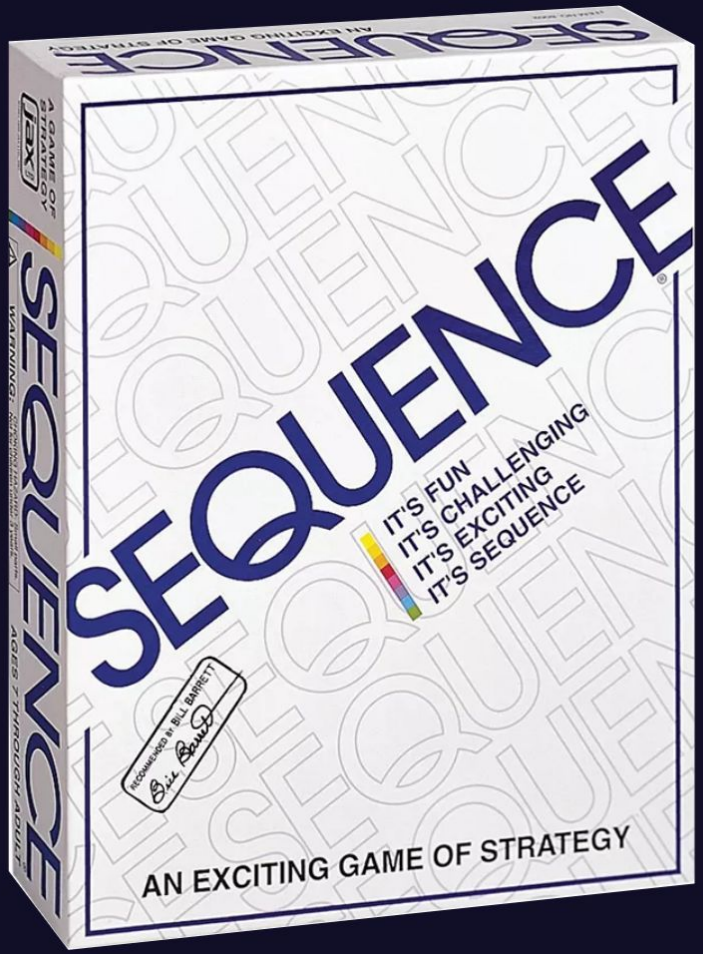
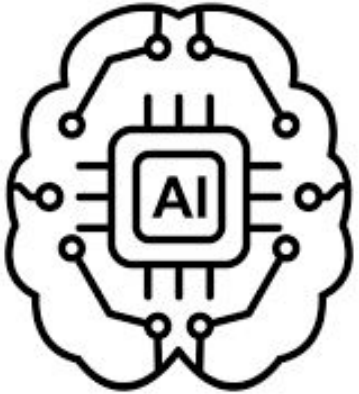
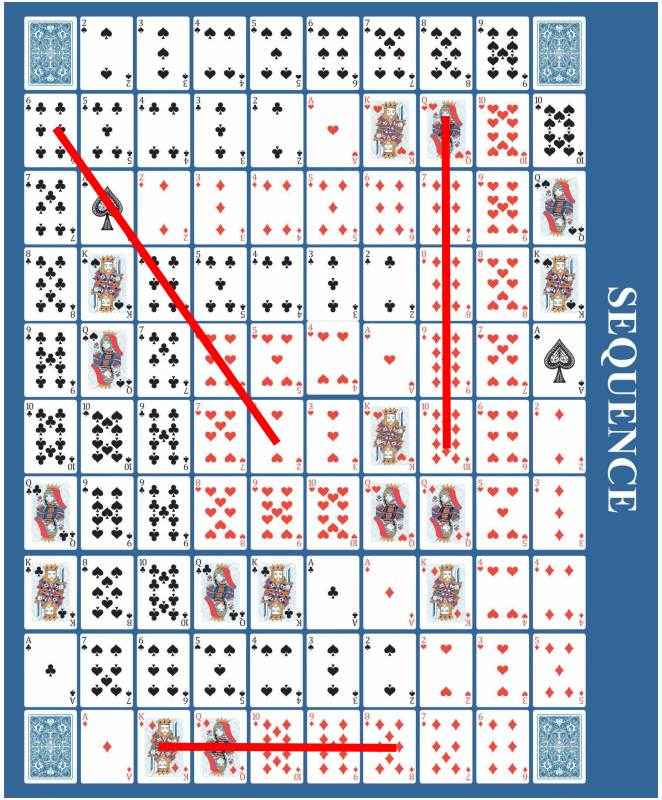


Sequence Board Game

Sahar Farzanehpour
Naga Sekhar Reddy Kambham
Ramin Salman Roughani
Tanya Dinesh

Goal: create an AI agent that can play the sequence game with a human player effectively.





How is Sequence played?

- A board game between two teams of players.
- Each team can include one to two players.
- Each player has 5 cards in hand.
- Goal is to make a sequence of 5 cards on the board (Vertically, horizontally, or diagonally).
- Cards are dispensed between the players with uniform probability and the game becomes more challenging when more cards are played.

Project Workflow Overview

- Developed the game board layout.
- Assigned red tokens to Player 1 and blue tokens to Player 2.
- Randomly distributed cards between players.
- Implemented the basic game for two human players.
- Introduced an AI agent as the second player.
- Opted for the Min-Max algorithm for the AI.
- Implemented Min-Max with alpha-beta pruning for enhanced performance.

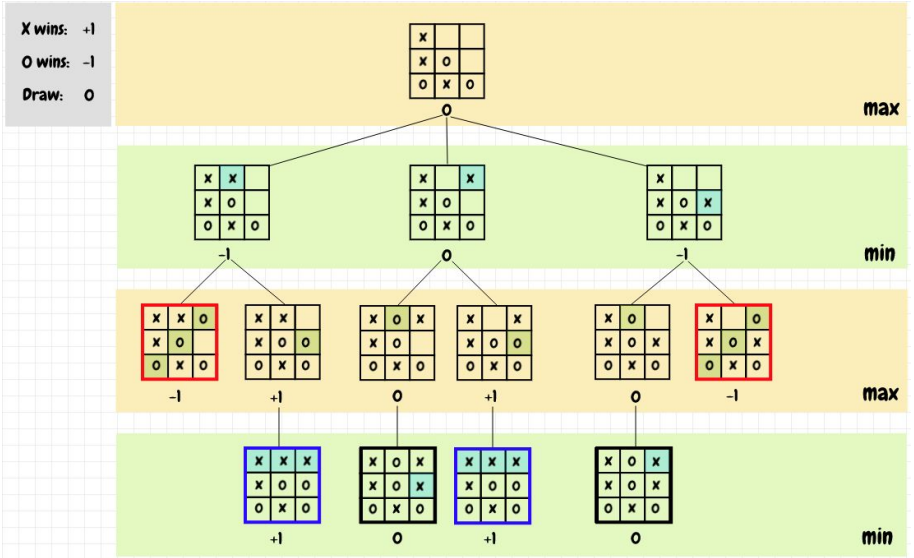
Steps involved:

- Game Tree Construction
- Evaluation Function
- Minimax Decision Making
- Optimization with Alpha-Beta Pruning
- Best Move Execution

Challenges Faced:

- Not knowing the legal moves the min player can make.
- Creating a robust evaluation function.

Implementation of Minimax in Sequence

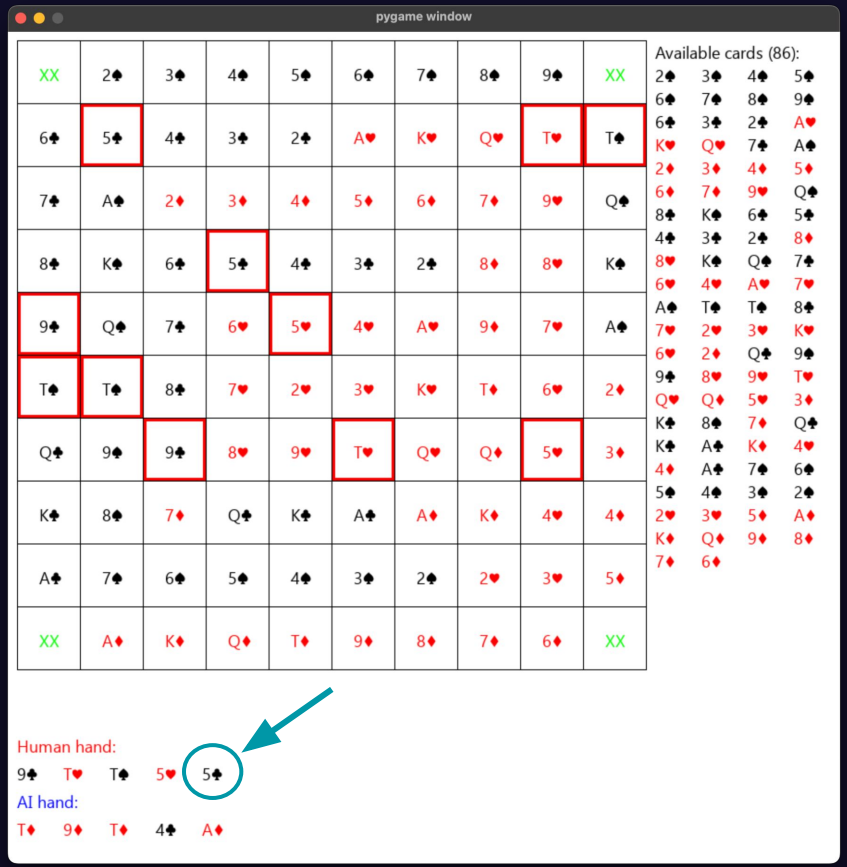


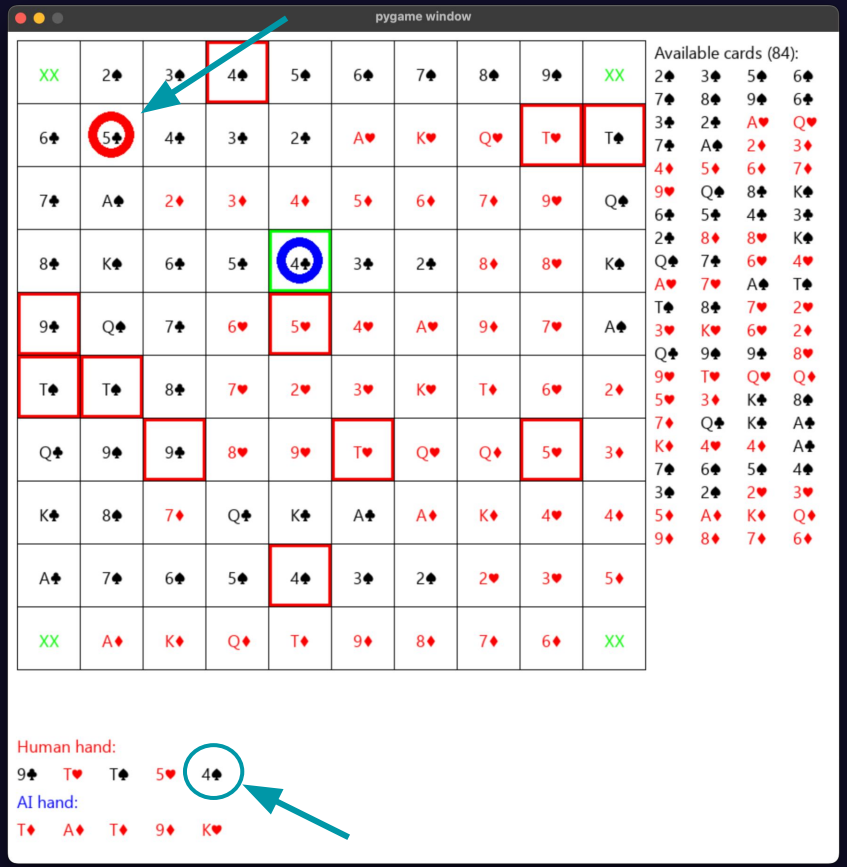
Solutions to the Challenges Faced

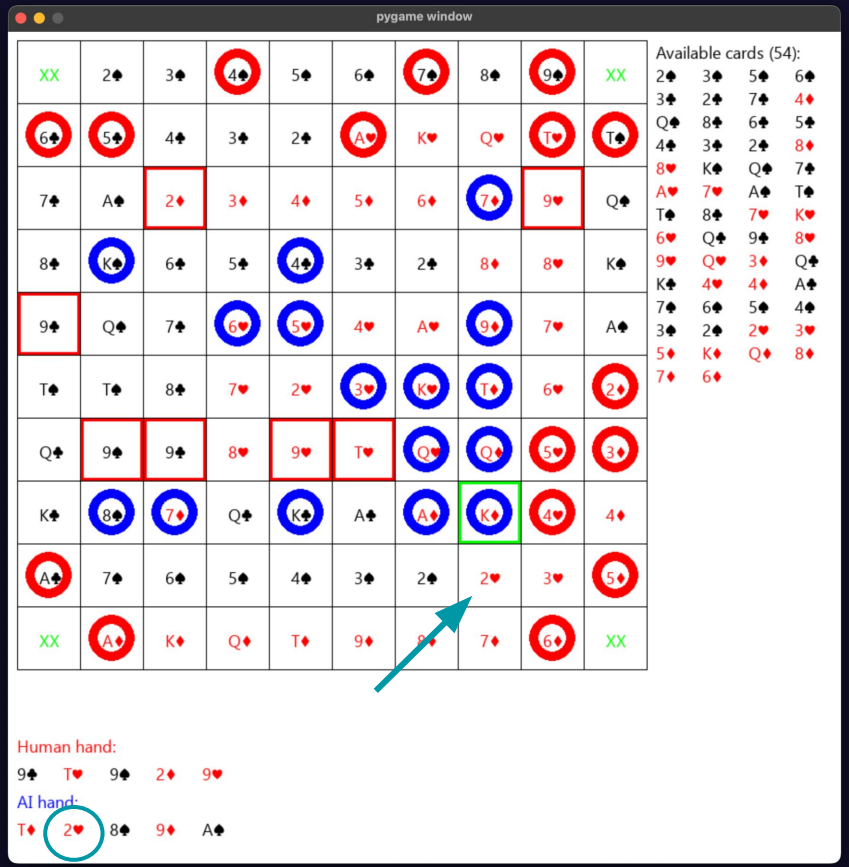
- Not knowing the legal moves the min player can make.
  - Since the AI agent cannot know which moves the opponent can legally make, it assumes that the player can place a token adjacent to any of its own squares on the board, thereby providing a list of moves from which the game tree can be constructed

- Creating a robust evaluation function.
  - The evaluation function takes into account the corner wild squares that belong to both teams.
  - Checks for every possible combination of cells where a sequence can be formed.
  - Scores are assigned based on the relative placement of tokens. eg: scoring for a potential sequence with 2 tokens is lower compared to a potential sequence with 3 tokens

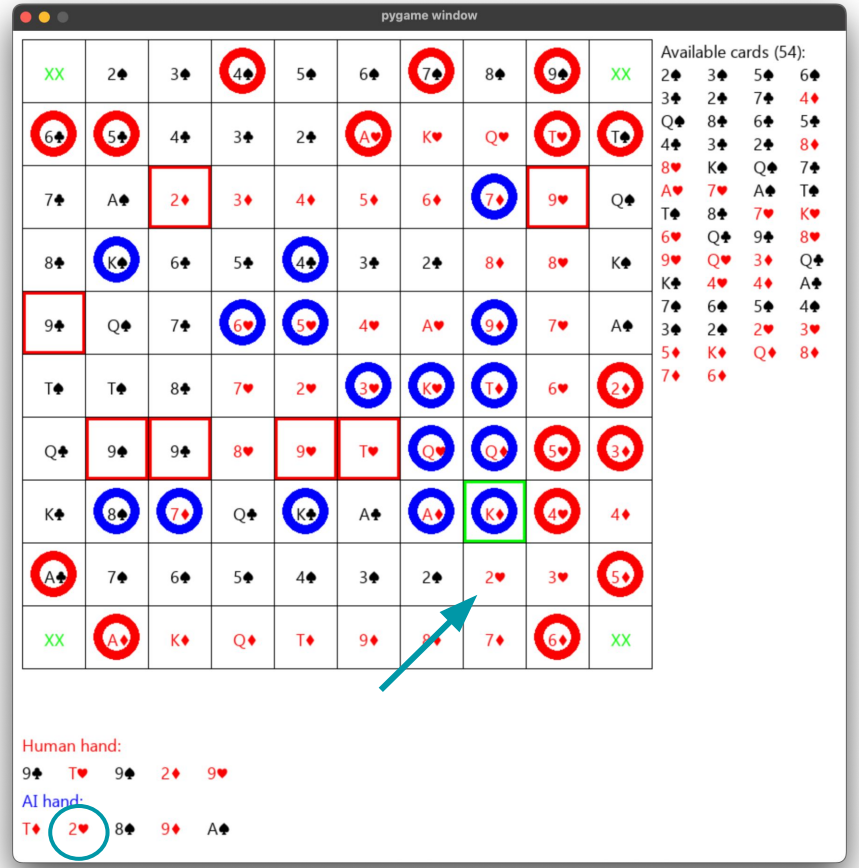
Demonstration


pygame window
XX 2♠ 3♠ 4♠ 5♠ 6♠ 7♠ 8♠ 9♠ XX
6♣ 5♣ 4♣ 3♣ 2♣ A♥ K♥ Q♥ T♥ T♠
7♣ A♣ 2♦ 3♦ 4♦ 5♦ 6♦ 7♦ 9♥ Q♠
8♣ K♠ 6♣ 5♣ 4♣ 3♣ 2♣ 8♦ 8♥ K♠
9♣ Q♠ 7♣ 6♥ 5♥ 4♥ A♥ 9♦ 7♥ A♠
T♠ T♠ 8♣ 7♥ 2♥ 3♥ K♥ T♦ 6♥ 2♦
Q♣ 9♠ 9♣ 8♥ 9♥ T♥ Q♥ Q♦ 5♥ 3♦
K♣ 8♠ 7♦ Q♣ K♣ A♣ A♦ K♦ 4♥ 4♦
A♣ 7♠ 6♠ 5♠ 4♠ 3♠ 2♠ 2♥ 3♥ 5♦
XX A♦ K♦ Q♦ T♦ 9♦ 8♦ 7♦ 6♦ XX
Available cards (86):
2♠ 3♠ 4♠ 5♠
6♠ 7♠ 8♠ 9♠
6♣ 3♣ 2♣ A♥
K♥ Q♥ 7♣ A♠
2♦ 3♦ 4♦ 5♦
6♦ 7♦ 9♥ Q♠
8♣ K♠ 6♣ 5♣
4♣ 3♣ 2♣ 8♦
8♥ K♠ Q♠ 7♣
6♥ 4♥ A♥ 7♥
A♠ T♠ T♣ 8♣
7♥ 2♥ 3♥ K♥
6♥ 2♦ Q♣ 9♠
9♣ 8♥ 9♥ T♥
Q♥ Q♦ 5♥ 3♦
K♠ 8♣ 7♦ Q♣
K♣ A♣ K♦ 4♥
4♦ A♣ 7♣ 6♠
5♠ 4♣ 3♠ 2♠
2♥ 3♥ 5♦ A♦
K♦ Q♦ 9♦ 8♦
7♦ 6♦
Human hand:
9♠ T♥ T♠ 5♥ 5♣
AI hand:
T♦ 9♦ T♦ 4♣ A♦


pygame window
XX 2♠ 3♠ 4♠ 5♠ 6♠ 7♠ 8♠ 9♠ XX
6♣ 5♣ 4♣ 3♣ 2♣ A♥ K♥ Q♥ T♥ T♠
7♣ A♣ 2♦ 3♦ 4♦ 5♦ 6♦ 7♦ 9♥ Q♠
8♣ K♠ 6♣ 5♣ 4♣ 3♣ 2♣ 8♦ 8♥ K♠
9♣ Q♠ 7♣ 6♥ 5♥ 4♥ A♥ 9♦ 7♥ A♠
T♠ T♠ 8♣ 7♥ 2♥ 3♥ K♥ T♦ 6♥ 2♦
Q♣ 9♠ 9♣ 8♥ 9♥ T♥ Q♥ Q♦ 5♥ 3♦
K♣ 8♠ 7♦ Q♣ K♣ A♣ A♦ K♦ 4♥ 4♦
A♣ 7♠ 6♣ 5♠ 4♠ 3♠ 2♠ 2♥ 3♥ 5♦
XX A♦ K♦ Q♦ T♦ 9♦ 8♦ 7♦ 6♦ XX
Available cards (84):
2♠ 3♠ 5♠ 6♠
7♣ 8♠ 9♣ 6♦
3♣ 2♣ A♥ Q♥
7♣ A♠ 2♦ 3♦
4♦ 5♦ 6♦ 7♦
9♥ Q♠ 8♣ K♠
6♣ 5♣ 4♣ 3♣
2♣ 8♦ 8♥ K♠
Q♠ 7♣ 6♥ 4♥
A♥ 7♥ A♠ T♠
T♠ 8♣ 7♥ 2♥
3♥ K♥ 6♥ 2♦
Q♣ 9♠ 9♣ 8♥
9♥ T♥ Q♥ Q♦
5♥ 3♦ K♣ 8♠
7♦ Q♣ K♠ A♣
K♦ 4♥ 4♦ A♣
7♣ 6♠ 5♠ 4♠
3♠ 2♠ 2♥ 3♥
5♦ A♦ K♦ Q♦
9♦ 8♦ 7♦ 6♦
Human hand:
9♠ T♥ T♠ 5♥ 4♠
AI hand:
T♦ A♦ T♦ 9♦ K♥




```
Move: (9, 4), Score: 1840
Move: (9, 5), Score: 1900
AI's Hand:  ['K♦', 'T♦', '6♥', '8♠', '9♦']
AI played:  6♥
Human's hand:  ['9♣', 'T♥', '6♣', '9♠', '2♦']
Human played:  6♣
================================================================
=======
Move: (0, 7), Score: 1990
Move: (5, 4), Score: 2220
Move: (7, 7), Score: 2450
Move: (8, 7), Score: 2150
Move: (9, 2), Score: 1910
Move: (9, 4), Score: 2000
Move: (9, 5), Score: 2010
AI's Hand:  ['T♦', 'K♦', '2♥', '8♠', '9♦']
AI played:  K♦
Human's hand:  ['9♣', 'T♥', '9♠', '2♦', '9♥']
Human played:  9♥
================================================================
=======
Move: (0, 7), Score: 2440
Move: (2, 1), Score: 2380
Move: (4, 9), Score: 2580
Move: (5, 4), Score: 2330
Move: (8, 7), Score: 3040
Move: (9, 4), Score: 2460
Move: (9, 5), Score: 2470
AI's Hand:  ['T♦', '2♥', '8♠', 'A♠', '9♦']
AI played:  2♥
AI wins!
saharii@Sahariis-MacBook-Air AI %
```




```
Move: (9, 4), Score: 1840
Move: (9, 5), Score: 1900
AI's Hand:  ['K♦', 'T♦', '6♥', '8♠', '9♦']
AI played:  6♥
Human's hand:  ['9♣', 'T♥', '6♣', '9♠', '2♦']
Human played:  6♣
================================================================
=======
Move: (0, 7), Score: 1990
Move: (5, 4), Score: 2220
Move: (7, 7), Score: 2450
Move: (8, 7), Score: 2150
Move: (9, 2), Score: 1910
Move: (9, 4), Score: 2000
Move: (9, 5), Score: 2010
AI's Hand:  ['T♦', 'K♦', '2♥', '8♠', '9♦']
AI played:  K♦
Human's hand:  ['9♣', 'T♥', '9♠', '2♦', '9♥']
Human played:  9♥
================================================================
=======
Move: (0, 7), Score: 2440
Move: (2, 1), Score: 2380
Move: (4, 9), Score: 2580
Move: (5, 4), Score: 2330
Move: (8, 7), Score: 3040
Move: (9, 4), Score: 2460
Move: (9, 5), Score: 2470
AI's Hand:  ['T♦', '2♥', '8♠', 'A♠', '9♦']
AI played:  2♥
AI wins!
saharii@Sahariis-MacBook-Air AI %
```

Link to the GitHub repository:

https://github.com/Sfrznp/SequenceGame

- Problems:
  - Previous implementation of Minimax function
  - AI being slow

- Possible improvements:
  - Make the agent faster
  - Try different algorithms
  - Currently only have 2 player option, possibly add the option to choose number of players
  - Have multiple agents play with each other

Questions?