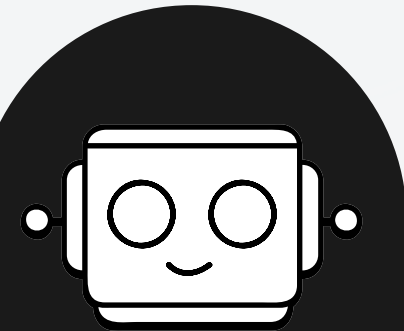# 15494 FINAL

CONNECT 4

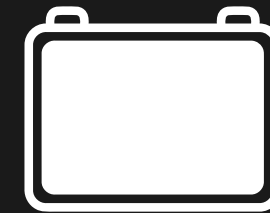BY AYDEN XU AND ERVIN SONG

ITEMS NEEDED

Cozmo is the robot we will be playing Connect 4 with and the cubes will help Cozmo determine the bounds of the Connect 4 Board!

COZMO + CUBES

GPT will help us communicate with Cozmo through text input!

GPT-4

This is the board that Cozmo will play Connect 4 on with the user!

BOARD

GOALS OF PROJECT

Objective n° 1

By integrating GPT-4's advanced capabilities with Cozmo's Hearing and Motor functions for engaging interactions. We teach Cozmo to play Connect 4, showcasing the collaboration between AI and robotics for dynamic gameplay.

OUR APPROACH

O1
SPEECH
Cozmo takes in speech input from the user asking whether the user wants to go first or second.

O2
PLAY
Using Prompt Engineering with GPT-4, Cozmo decides on a column to drop the piece.
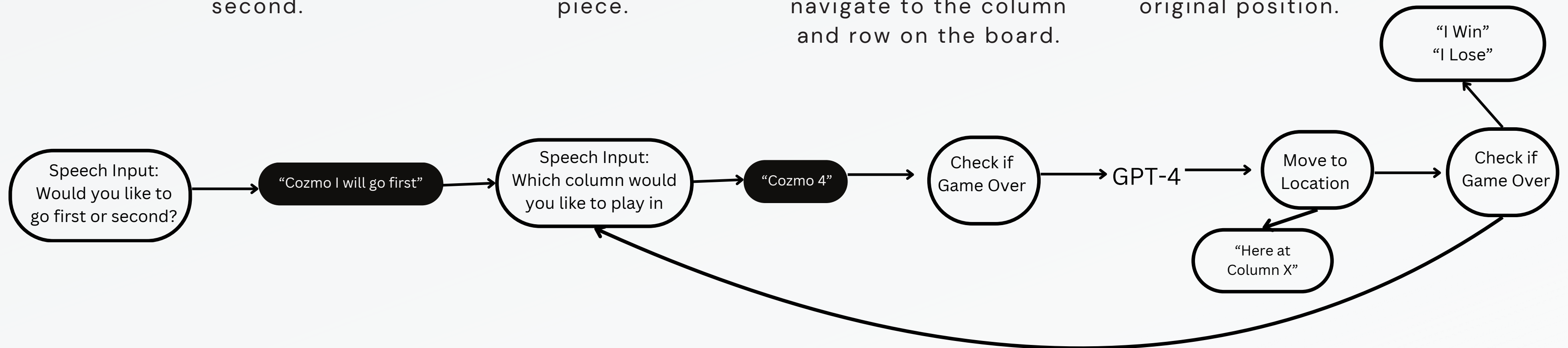
O3
MOVEMENT
Using column that GPT decides, we use the distance of the cube to Cozmo help cozmo navigate to the column and row on the board.

O4
ITERATE
During each turn, we check if someone has won, if not, revert Cozmo back to its original position.

USING GPT-4

Initial Prototype:
Simply ask GPT to play a game of Connect 4.
- Played the game poorly

Refinement 1:
Prompt Engineering: Give GPT a set of rules to follow in order to win
- Started making better moves, but sometimes played illegal moves

Refinement 2:
Ask GPT for the best move given a board state.
Provide few shot prompts of optimal moves after playing many games.
- Played better moves than initial prototype
- No more illegal moves

```
You are a unbeatable connect 4 bot. Please follow the rules and strategies below to win the game:

1. If there is a winning move, take it.
2. If your opponent has a winning move, take the move so he
can't take it.
3. Take the center square over edges and corners.
4. Take corner squares over edges.
5. Take edges if they are the only thing available.
```

```
Late Game Strategy for Connect 4:
Consider this advanced stage in a Connect 4 game where the board state is as follows:
- - - - - - -
- - - R - - -
- - R Y R - -
- Y R Y Y R -
R Y Y R Y Y R
R Y R Y R R Y
Yellow is playing next. Think through this turn by considering potential setups for future moves as well as immediate threats.

1. Assess immediate win conditions: See if placing a yellow disc results in four in a row.
2. Evaluate if there is a need to block: Look for places where red might win on their next turn and block them.
3. Consider future setups: Look for spots that don't just react to red's threats but also create two-point scenarios where yellow might ha
4. Decide on the most strategic column after considering both defensive and offensive strategies.
```

OTHER CONSIDERATIONS

Example Board

```
|.|.|.|.|.|.|.|
|.|.|.|.|.|.|.|
|.|.|.|.|.|.|.|
|.|.|.|.|.|.|.|
|.|.|.|.|.|.|.|
|.|.|.|.|.|.|.|
|1|2|3|4|5|6|7|
```

- We needed a way to pass updated boards into GPT because GPT was really bad at remembering what the board looked like
- To do so, we used an array and an array to string function
- We would update the board globally after every turn made my GPT and the user

Realignment

- Each turn by cozmo, cozmo will drive to the column it wants to move in
- To know where the column is, it finds the distance to either cube 1 or 2
- It drives there and says here and drives back
- It will realign itself according to the position of cube 1 or 2

OTHER CONSIDERATIONS

GPT Response

- GPT returned a full sentence so we would have to extract a column
- Initially, we iterated through, but that was unreliable
- Prompt Engineered GPT to return only a column
- Led to a problem where GPT could not determine if game was over
-

Check Function

- Checked the board state for a winner and returned the winner
- Simplified the board into a 2d array representing the filled columns
- Checked the 2d array for connected rows, columns, and diagonals
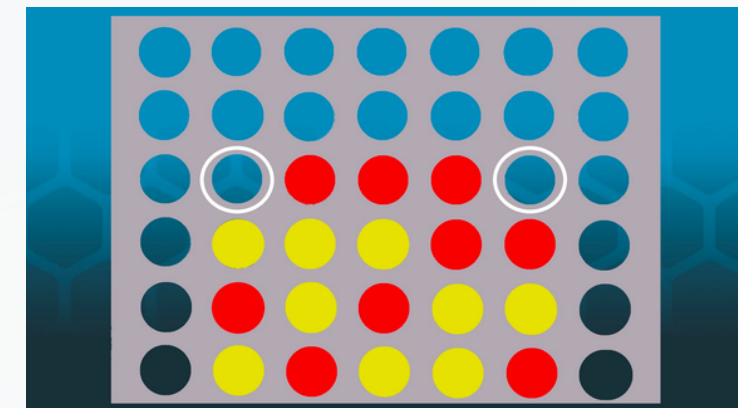
FUTURE WORK

Here are some imporvements we hope to make

Have Cozmo show more emotion with its move and when it lose or wins. For example, when Cozmo wins, it can pop a wheelie, and when it loses, it could throw a tantrum by picking up the cubes

INTERACTIVITY

We could have Cozmo see an actual four in a row board and take in that information as the updated board. This could probably be implemented with GPT-4 image recognition.

COMPUTER VISION

We could insert an option to allow Cozmo to implement an algorithm where it nevert loses. As there are implementations of this online.

UNLOSEABLE

Video Demo

https://youtu.be/SYgE5396V_8