

Beza Amsalu : baa2159

Miira Efrem : me2738

COMS 4995: Parallel Functional Programming

November 28, 2022

## **Project Proposal - Connect4**

For our final project, we're intending to implement a parallelized version of the Minimax algorithm, particularly for the use case of solving a Connect4 game.

### **Background**

Connect 4 is a game played by two agents, where each player has 21 balls, differentiated from each other by color or another characteristic. The players take turns dropping a ball into a grid of six rows by seven columns, where the ball fills the lowest unoccupied slot in that column. Because building a GUI for our game is a stretch goal, the balls for the players will be differentiated on whether they're filled in or not. A player wins the game, if they achieve 4 balls adjacent vertically, horizontally, or vertically first. When implemented digitally, the Minimax algorithm, which is a backtracking algorithm, is used to look ahead and pick a position that will either maximize the chance of the computer winning, or conversely, the move that will minimize the player's score. Because of the recursive nature of the minimizer and maximizer functions and the algorithm's exponential runtime, it is a good candidate for parallelization.

### **Performance Evaluation**

1. Players win when meeting winning conditions [4 vertically, horizontally, or diagonally adjacent balls of the same color]
2. Parallelized version consistently achieves faster runtime than the sequential version of the game

### **Plans for optimization**

1- Using threadscope to ensure that work is split among all CPU cores and none of the cores are idle.

2- Ensuring balance between creating enough work for CPUs and creating too much granularity, forcing too much overhead that undermines the speed-up we gain from parallelization.

3- Possibility of implementing alpha-beta pruning with the Minimax algorithm would speed up the search time for finding the optimal move as it will significantly decrease the number of possible moves that need to be evaluated

### **References**

[Connect Four \(Mini-max algorithm explained\)](#)