Connect 4

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1 Team members

No team members.

2 A brief description

For my project, I will be exploring the classic board game Connect 4. I will use what I have learned in class to create an algorithm that will play the game as close to perfection as possible. This game appealed to me as I have played Connect 4 for a while, and have gotten to learn a pretty solid strategy. I believe it would be fun to implement an A.I. algorithm that uses my strategy and plays with a much higher level of consistency. One thing to note, Connect 4 is a SOLVED game. There are in total 4,531,985,219,092 [Mar13] possible positions in Connect 4, and each has a solved specific outcome stored in an 8-ply database compiled by John Tromp.[Tro] Instead of the classic game, I will implement my algorithm to play on a 7 row by 8 column grid as I find that grid size more interesting.

3 The approach

My initial version of the algorithm will consist of a simple breadth-first search, checking all possible outcomes for playing on each of the 8 columns. With basic breadth first, the algorithm should be able to traverse 6 or 7 turns as it is realistic to search 8^7 (2,097,152) outcomes in a reasonable amount of time. After this simple implementation, I will start reducing the columns to search based on the strategies that I implement into a heuristic. There are additional strategies I may reference in [All90]. This will allow the algorithm to traverse to greater depths. For example, if the algorithm identifies only 3 columns that are worth exploring, then it becomes realistic to traverse greater depths such as a depth of 13 (as $3^{13} = 1{,}594{,}323$).[Pea]

4 The software

I'm still deciding which language to write this algorithm in. I'm leaning towards Java as it is generally more efficient with these large sorts of computations, but I could certainly write it in python as that has been the language used in this course. I fully intend on writing my software from scratch as I already have a solid background with creating Connect 4 algorithms. I will reference my past work and improve upon it to use a proper search algorithm with an effective heuristic.

5 Preliminary results

I have written Connect 4 algorithms in the past, but that was before I had any knowledge of advanced search and A.I. algorithms. While on the surface my old algorithms were somewhat effective, they lacked a deep search of future outcomes. My original algorithms focused on the classic version (6x7) of Connect 4, so for this project I will be working with a larger playing grid (7x8). With what I have learned in class, I should be able to generate a much stronger algorithm that plays the game at a much higher level and depth.

6 Evaluating the solution

I will generate a heuristic that evaluates the current state of the board. The heuristic will come from the strategies that I implement into the algorithm. For example, without knowing the end result, my algorithm could estimate how well it is doing based on the number of 3-in-a-rows it has versus the player. That is just one basic example, my final heuristic will be more involved than that. I will test my A.I. algorithm against myself and other computer programs that play the game. I will see how it fares against those algorithms and evaluate its results.

7 Time frame

I will follow the guidelines outlined on canvas. As far as the individual parts of the project are concerned, here is my plan on how to approach this problem. First, I will create a working representation of Connect 4. Then I will create a simple breadth-first algorithm to play the game in a basic way. Then I will program my strategies into a heuristic that the algorithm will use so that it avoids branches that would not be worth exploring, thus allowing the algorithm to explore at greater depths.

References

[All90] James Allen. Expert play in connect-four. 1990.

[Mar13] Martin Thoma and Ivan Loh. How many different game situations has connect four? https://math.stackexchange.com/questions/301106/how-many-different-game-situations-has-connect-four, 02 2013.

[Pea] Adam Pearce. Connect 4 ai: How it works.

[Tro] John Tromp. John's connect four playground.