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Connect Four Algorithm Report

Even a game like Connect Four demands that a player uses both offensive and defensive strategies in order to win. As such, our group decided it would be necessary to combine offensive and defensive heuristics, choosing a hill-climbing search algorithm with a depth bound of one. We decided that a hill-climbing strategy would be the best way to make a difficult computer opponent, without making it impossible for the human player to win.

Every time the computer takes a turn, it generates all possible moves as children nodes. The algorithm then evaluates the heuristic value of each node based on patterns it finds in the game states of the possible moves. The closer to a win that a potential move is, the higher the heuristic value given. After assigning values, the algorithm compares all the heuristic values and chooses the child node with the highest value.

Defining our heuristic values took a bit of fine-tuning. We started by defining different win types (vertical, horizontal, forward diagonal, backward diagonal), and searching the children nodes for these patterns. The closer to a win-pattern that a child node is, the higher the value it is given.

To ensure a win whenever possible, win patterns were given the highest values. A move that blocks an opponent from winning was given the second-highest value, to make sure that the computer would play defensively when able. Any move that would cause the computer to set up the human player for a win was given a value of -1500 as another defensive feature.

For instance, a child node that has two friendly pieces stacked vertically is given a value of 20, a node with three stacked vertically is given a value of 40, and a node that contains a vertical win is given a value of 2000. A node containing a move that immediately blocks the human player from winning vertically is given a value of 1000.

While a win move was always granted the value of 2000, not all our patterns were valued equally. This is based on the likelihood of achieving victory from the different types of patterns. A single piece in a diagonal pattern is harder to complete than one piece in a vertical pattern due to the diagonal having more requirements, such as other pieces ascending or descending appropriately.

In summation, we used a hill-climbing search with a depth bound of one. Our algorithm searched all possible moves, assigning a heuristic value based on how well it matched win patterns. Our program has both defensive and offensive moves build-in to make it a more challenging opponent. The end result was a very difficult game of Connect Four, which we have only beaten a handful of times ourselves.