Research Review - Game Tree Searching by Min / Max Approximation

Summary of paper's goals and techniques

This paper discusses the possibility of enhancing the minimax iterative method by approximating the values of the "min" and "max" operators, with the help of generalised mean-valued operators. The purpose of this algorithm is to reduce the computational burden and cost of exploring a game tree.

This method is carried out using a heuristic that works on expanding the respective node that is most likely going to have the largest effect on the values; i.e. forcing the computer to only look at important lines of play and search some branches more deeply than others.In addition, the function delivers good approximations but also provides continuous derivatives to all arguments; thus proving to be more useful in sensitivity analysis.
The heuristic requires a single evaluator, then expands the game tree by looking at the child of the root with a maximum value. It is stated that the algorithm would work better when looking at the child of the root because it has a potential to look at all the different ways a min/max value can be achieved. After that, it works on assigning a penalty/weight to the edges of the node instances in the game tree; i.e. the penalties are just derivatives of the approximating functions.Lastly, edges which are considered to be bad moves will be penalized and carry more weight than the edges that are considered to be good moves. Consequently, this will expand the node with the least penalty/weight.

Summary of paper's results and limitations

The heuristic function was tested using the Connect-four game. In each of the 98 games that were conducted, the number of wins and ties were recorded. According to the results, the algorithm only performed better when "move" operators were used, whereas when time usage alone was considered, the alpha-beta seemed superior; this is because the alpha-beta algorithm was capable of considering more distinct positions when compared to the latter.
While conducting out the experiments, it was evident that the heuristic performed more efficiently in searching the parts of the tree that were promising; this is due to the fact that the remaining penalty nodes were only exposed to a shallow search before being skipped by the algorithm to a more promising node.
In addition, the heuristic also focused mainly on improving the value of the estimate on the root. However, it was noted that there were some limitations when compared to depth-first schemes due to the cost and time this penalty-based method took as it was traversing between the root and leaves of the game tree.

In conclusion, while this new approach out-performed the Alpha-beta algorithm in a "move" operated approach, it left the researchers with new problems to consider in regards to choosing the best mean-value function, and the adaptability of their approach when combined with more traditional heuristics in the game solving arena.