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Game Tree Searching by Min /Max approximation – MIT paper summary

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In this review, I will show a summary of the paper “Game Tree Searching by Min /Max Approximation” this paper presents a new method to proximate the min and max operators in tree searching by introducing a generalized mean-value operators.

Since exploring a tree is computational task and the limitation of CPU speed is a real problem so the importance to minimize the processing time is needed. Alpha-beta pruning is one of the essential techniques to save the processing time. Generalized-means is more suitable for “sensitivity analysis” than min/max functions.

The heuristic approximations are needed in case of large game tree, in fact selecting a depth bound is important to compute the score of those nodes at that depth using alpha-beta pruning, in addition limiting the search ”Iterative Deeping” by a timing-out to handle deeply trees in also essential.

Pathological games are one of examples which proves that going deeply into trees is not the optimal way to get an accurate move.

Penalty-based is one of iterative search methods which considers weighting the edges with wrong moves by negative values and good moves with positive values so the total penalty for specific terminal is the sum of all edges weights from that terminal to the main root.

The implementation of min/max approximation has different ways; we can compute the back-up estimate at the root node hence selecting the child of the root with maximum value instead of selecting the child itself – another way to implement min/max approximation is to skip the computation of the generalized mean-values and using suitable min/max values. The reverse approximation is the variation of using the derivatives of the generalized mean-values not the values themselves.

The static evaluation function have been used in all game-playing strategies and the evaluator returning a range of integers [1->1023] since 1 reserved for winning the minimizer and 1023 reserved for the winning of maximizer. In addition there is two resource bounds will be taken in account for each strategy; elapsed CPU time and calls to the basic moves. Since depth-first search is so complex; so minimax search with alpha-beta pruning have being used to reduce the processing time and reducing the tree-searching complexity. Reverse approximation and edges penalties are the main factors in implementing the penalty-based heuristic.

The results of this paper shows that the alpha-beta pruning performs better that minimax algorithm in using CPU time bound in contrast minimax is the winner if we used moves bound.

Although the penalty-based schemes are performing well but they are memory consumers. The most important advantage for using penalty-based schemes is the orientation that it’s follows; it goes to improve the value of the root node rather than selecting the best move.

The disadvantages of penalty-based and depth-first schemes are pretty clear; the most of the consumed time for penalty-based schemes in traversing back and forth between the root and leaves but in depth-first schemes the time spent near the leaves, however the penalty-based schemes can be adapted to perform same like depth-first schemes.