Research Review:
https://people.csail.mit.edu/rivest/pubs/Riv87c.pdf

Game Tree Searching by Min/Max Approximation

by Ron Rivest, MIT

In light of the implementation of minimax search with alpha-beta pruning in game tree search approximation, this paper presented a penalty-based iterative approach of min/max tree searching using generalized mean-value operators to select the leaf node to expand. The paper further compared this method with traditional minimax search methods regarding time constraint and number of move constraint. Finally the author provided thoughts and suggestions regarding the implementation details.

The key idea of reducing computational burden of game tree search is to find and expand the node with the largest effect of value to made the decision. Based on this purpose, this paper proposed to approximate the min and max operators with generalized mean-value operators. The reason of using generalized mean-value is that the generalized mean-value is more sensitivity than min or max. This paper used the penalty-based (or weight-based) iterative search method that is to assign different penalties to each node representing bad nodes with more penalty and then expand the least penalized node first.

Furthermore, the paper implemented this method and compared it with the traditional minimax search with alpha-beta pruning in the near 1000 games of Connect-Four experiments. With the CPU processing time limit constraint ranging in 1-5 seconds, minimax with alpha-beta pruning method is superior to generalized mean-value method. However, when the number of move operator is limited, the generalized mean-value search performs better than the other. This represents the impact of processing memory in these two approaches, whereas the generalized mean-value search needs to trace back from nodes to root every time and therefore requires more memory.

In conclusion, this generalized mean-value search method performs well given a large amount of memory but may appear to be less efficient compared to depth-first search, such as minimax with alpha-beta pruning.