# RESEARCH REVIEW

GAME TREE SEARCHING BY MIN/MAX APPROXIMATION. (RONALD L. RIVEST)

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## INTRODUCTION

The paper "Game Tree Searching by Min/Max Approximation" by Ronald. L. Rivest proposes a new technique as an alternative to minimax search with Alpha-Beta pruning, consisting of the use of the mean-value as an approximation to min and max values.

## GOALS AND TECHNIQUES

Although the minimax algorithm with A-B pruning is widely used, the paper sustains that there are still improvements to be made to find a method that will always expand the node that is expected to have the largest effect on the value.

The fundamental sustained reason for using that new approach is that considering large search trees the traditional method needs some approximation in order to gain sensitivity metrics, and the generalised means are more suitable for a sensitivity analysis than the min or max functions.

An indicator of the sensibility of the node is done by taking derivatives of the generalised mean value functions at each node and using the chain rule. The most suitable leaf will be the one to expand next.

Min/Max approximation is a penalty-based iterative search method. Iterative heuristics, in general, grow the search tree one step at a time. At each step, a tip node(or leaf) of the current tree is chosen, and the successors of that tip node are added to the tree. Then the values provided by the static evaluator at the new leaves are used to provide new backed-up values to the leaves' ancestors. The tree grown by an iterative heuristic need not be of uniform depth.

In these sort of methods, how the leaf is chosen to expand? Assigning nonnegative weights to every edge in the game tree such that edges representing bad moves are penalized more than edges are representing good moves. The 'penalty' of the tip is the sum of the penalties of all the edges between that current node and the root. Therefore, the tip with least penalty is chosen to be expanded, and its children are added to the tree.

In particular, the min/max approximation heuristic is a special case of the penalty-based search method, where the penalties are defined regarding the derivatives of the approximating functions. The derivatives of the approximation functions measure the sensitivity of the root node to changes in the tip.

## RESULTS

Experimental results from 1,000 of Connect-Four games suggest that this new approach suggested improves the minimax search with alpha-beta pruning, for the same number of movements. However, the downside is that this new scheme has a higher overhead. Time computation and resources used are important metrics while evaluating solutions for playing games. Therefore, this methodology still needs more improvement.