Summary: Game Tree Searching by Min / Max Approximation

Paper's Goal:

The goal of the paper is to introduce a new technique in game tree search using min/max approximation with a generalized mean-value operator.

In a tree, as the depth increases, nodes to be searched grow exponentially according to its branching factor. While exploring game tree, techniques like alpha-beta pruning help in reducing the computational burden by excluding non-optimal branches. However, there are many complex games for which the game tree is so large that we need new techniques to explore the tree in more innovative ways.

The paper discusses one such technique based on heuristic approximation using a static evaluation function. The function estimates the backed-up value for a non-terminal node without further look-ahead

The idea is to approximate the min and max function in a computationally efficient way and to identify the expandable tip upon whose value the backed-up value at the root most heavily depends. The identified node will be expanded in next iteration

Result Summary:

To approximate the min and max function a generalized mean-value operator is used. The benefit of this generalized operator is that it not only provides a good approximation but also have continuous derivatives with respect to all arguments. These generalized means are good for “sensitivity analysis” as well. To identify the leaf in a game tree upon whose value the backed-up value depends significantly, the paper is using chain rule on the derivatives of the generalized mean-value function.

The "min/max approximation" heuristic explained in the paper is a type of penalty-based iterative search where penalties are calculated by derivatives of generalized mean-value function with respect to all arguments. The iterative search grows the search tree one step at a time by selecting a tip node and adding its successors. Then the static evaluation function provides the backed-up value to the ancestors.

The experiment compares performance of "min/max approximation" with “alpha-beta pruning with iterative-deepening” and conclude that the former outperforms the later when both are restricted to same number of call to the move operator.

The paper also claims that the “min/max approximation” scheme uses the resources in an efficient way by performing shallow exploration of an un-promised section of the tree and deeper exploration of promising part.