Research Review
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Game Tree Searching by Min/Max Approximation by Ronald L. Rivest[1]

This paper aimed at introducing a new technique - “min/max approximation” - for searching in game trees. It uses generalized mean values to select the next leaf to expand whose value at the root most highly depends. The first part is an introduction of why a new method is needed in the area of searching a game tree. Section 2 illustrated in detail what generalized mean values is and it is followed by an application to searching game trees. Implementation details are presented afterwards. Finally, the author described results and thoughts for this method.

Current practice using alpha-beta pruning proves to be efficient with small trees, but sometimes the game tree is so large that heuristic approximations are needed. To select which node to expand, this paper introduced penalty-based iterative search methods, which basically assigns a nonnegative penalty to every edge in the tree such that edges representing bad moves are penalized more than those represents good moves. Then this method only expand the tip node which has the least penalty.

Min / max approximation is a special case of the penalty based search method, and the penalties are defined in terms of the derivatives of the approximating functions. To implement this idea, there are a few ways to deal with the computational difficulty to compute the generalized p-means. One way is to compute the generalized means exactly, another way is “reverse approximation”, which skip the computation in the first method and use the appropriate min or max values. The experimental results demonstrated that the new method proposed in this paper has better performance than the minimax search with alpha-beta pruning. However, it has higher overhead.

Overall, this paper is a great example that serves as a basis to understand the complexities behind building a successful game agent. The unsolved problems are also great sources of inspirations for future improvement of current practices.

[1] https://people.csail.mit.edu/rivest/pubs/Riv87c.pdf