*A brief summary of Game Tree Searching by Min/Max Approximation**
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In this paper Professor Ronald L. Rivest introduces a new approach for searching game trees using generalized mean value functions to create approximations of Min/Max values used to direct the search of the game tree. Rivest demonstrates this technique using the popular game *Connect Four*, a perfect information zero sum game much like the game *Isolation*. Compared against the familiar minimax search with alpha-beta pruning technique *Min/Max Approximation** showed superior play when the number of calls to the "move" function is used as the limiting factor. However if CPU time is the limiting mini-max with alpha-beta pruning showed superior play.

When playing a game with a small number of possibilities, a small the tree can be completely explored therefore optimal play is achievable. When playing with slightly larger games a mini-max function with and alpha-beta pruning can be used, which may also provide optimal play without exploring tree by traversing only the relevant sections of the tree. However the most interesting games, i.e. Go or Chess create such large trees that we require a heuristic function, which is essentially a hunch to guide the traversal because classic methods are too slow and the search space too large to foresee the end of game. A common approach to searching a very large game tree is to use Iterative deepening depth first search to limit the amount of computation time. Iterative deepening selects a suitable depth as a bound before a timeout can occur and computes the values of nodes at each depth level from the root down using a static evaluator and increases the depth until a goal is found. Because the tree expands by branching earlier smaller searches can be computed as backed-up minimax values to provide a branch ordering for deeper searches.

The *Min/Max Approximation** technique provides a honing of the computer's focus along the most significant elements of play using an approximation operation instead to guide the search. The approach uses continuous derivatives to create an "expandable tip upon whose value is pure backed-up value at the root most heavily depends." A penalty value is defined in terms of derivatives of the approximating function and applied to every edge in the tree; edges representing bad moves are penalized over good moves. The node to estimated have the greatest affect on the move function is then selected to be expanded for further exploration. The "expandable tip" allows the machine to reduce the scope of exploration within the game tree to a path. Through the use of an iterative heuristics approach the search tree grows a single node in a step rather than naively exploring an entire tree level at each step.

Game play is a very interesting environment in which to study artificial intelligence because ideas because its controlled within a definitive set of rules. I found the Min/Max Approximation* much more intriguing than the naive ordering approach used minimax search with alpha-beta pruning. After reading this paper I'm left wondering how in/Max Approximation* could be used along with more rational approach to get the efficiency of depth-first search.

Reference:

Rivest, Ronald L., *Game Tree Searching by Min/Max Approximation.* Laboratory for Computer Science, MIT, Cambridge MA 02139, U.S.A.