# Research Review

Research paper "Game Tree Searching by Min/Max Approximation" written by Ron Rivest was reviewed and analyzed. The paper brings a new spin and heuristic technique to solve a complex game-playing problem without using the Alpha-Beta pruning and providing better results in certain conditions than Alpha-Beta pruning. The author/researcher used the idea of approximating the min and max operators with generalized mean-value operators. The method looks to expand the node that is expected to have the largest game-winning chance by using mean-value theorem. In short, the paper talks about using the generalized mean value to approximate the min and max functions and find the leaf in a game tree upon whose value the value at the root depends most strongly. This is done by taking derivatives of the generalized mean value functions at each node and using the chain rule.

The author ran a few experiments with this new approach and compared the results to a regular Alpha-Beta pruning method and identified during this initial experimental results that the new approach of mean-value approximation produce superior results when compared to the minmax search with alpha-beta pruning; however, there was some limitations associated with it. The new approach produced better results only when the CPU time is not limiting resource and the search is done based on a set number of moves. When CPU time is a limiting resource then the minmax search with alpha-beta pruning is better since the new approach takes additional time to compute the mean-value approximation and does not produce the best results in the given time frame.

The experiment consisted of 98 games using two method i.e. alpha-beta pruning and minmax search with mean-value approximation. There were two sets of experiments ran; one with time bound ranging from 1 to 5 seconds with 1 second intervals and the second with move bounds ranging from 1000 moves to 5000 moves in 1000 moves interval. For each experiment, it was recorded how many times each strategy won and how many ties occurred.

It was noticed that based on time alone, alpha-beta pruning was superior compared to the minmax approximation; however, if it was based on moves alone, then minmax approximation was superior over alpha-beta pruning. The total number of distinct positions considered by alpha-beta pruning was approximately three times larger than the number of distinct positions considered by min/max when a time bound was in effect. When a move bound was in effect the number of distinct positions considered by each strategy was roughly equal; the fragmentation lossage of alpha-beta seemed to equal the inefficiencies of the min/max routine having to redescend the tree for each expansion.

Based on the initial experiments and results, it was demonstrated that the new approach of minmax approximation showed promise in certain constraint situations and could be further improved if investigated and looking into more.