Null Move Pruning: Reduction of search space in chess agents

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Abstract

In 1997 IBM’s Deep Blue chess machine beat world chess champion Garry Kasparov in a series of six matches. Deep Blue was able evaluate 200 million moves per second with its highly parallel custom designed chess processors. With this kind of throughput, Deep Blue was able to brute force search deeply enough that it was able to succeed where all others had failed – to beat a current world chess champion. Despite Deep Blue’s success, it is also the last truly successful chess agent to use brute force search strategies. Today’s state of the art agents such as Shredder and Fritz rely on forms of forward pruning that cut down the search space dramatically while minimising any potential loss of search stability. As such they are able to operate effectively with hardware that is dwarfed by Deep Blue.

I will introduce ‘null move’ pruning, a heuristic that can be used to evaluate the strength of a position without searching to the full minimax search depth. Using this technique an agent is able to search to a greater ply and is arguably a better player. This technique operates by letting the simulated opponent take two consecutive moves and searching to a reduced depth. This null search can be used to approximate the lower bound of the utility for a given move which can be used to prune a proportion of the search space. As the null-move search is made with reduced depth, this technique can result in a practical increase of one or two ply at the expense of some search stability.

As there are some problems with this technique when it encounters zugzwang positions and horizon effects, I will discuss ways of minimising their impact. The evolution of this technique will be shown,
starting with the null move heuristic popularised by Donninger [1]. Adaptive null-move pruning by Heinz [2] which dynamically selects an appropriate depth for the null move search will then be described. By using the optimal depth, this technique is able to limit tactical blunders while retaining most of the reduction in search effort. Finally, verified null-move pruning by Tabib et al. [3] will be described. This is an extension to standard null move pruning that uses a null-move search with smaller depth than other techniques and in the case of a null-move cut-off verifies it with a reduced depth search. By doing so, it limits horizon effects and is able to do so in less time than adaptive null pruning.

When used correctly, the null move heuristic is a powerful technique for extending the depth of a minimax search in computer chess. If certain board configurations are carefully avoided and the horizon problems inherent in the null move heuristic are minimised, a chess agent using the null move heuristic has a huge advantage over other agents. This fact is evident from the reign of chess agents using this technique in recent computer chess tournaments.

References

