Artificial Intelligence Nanodegree

Deep Blue Research Review

d.serrano1524@gmail.com

Summary

The paper describes the Deep Blue computer chess system developed by IBM in the mid 1990s. The paper describes the specs and considerations taken to create Deep Blue I (first system designed to beat a Chessmaster that lost to Garry Kasparov, Chess World Champion in 1996) and the algorithmic and hardware improvements taken to create Deep Blue II, which was able to defeat Kasparov.

A system overview describes the 30 node machine and it's 3 layer architecture, which was able to process in average 100 million chess positions per second. It's also specified how they relied on techniques such as quiescence search, iterative deepening, transposition tables and NegaScout to create the system.

A section is dedicated to explain the overview of the chip used on Deep Blue. They give a description of the move generation, evaluation function and search control components of it. Following that section, the principles on which selective search was designed are introduced. It includes the description of tactics such as forced moves and fractional extensions between others.

Furthermore, a description of the hardware parameters selected and the parallel search algorithms are explained on a high level overview. Important taxonomy concepts are introduced to explain the parallel search algorithm and it's implementation, taking into consideration major issues such as load balancing, master overload and sharing between nodes.

At last, the overview of the evaluation function describes the patterns, values and features that the chess chip is able to recognize, along with the automated function analysis. The opening book and extended book creating and use is discusses as an additional feature.

New Techniques

To create Deep Blue, techniques that existed previously such as quiescence search, iterative deepening and transposition tables were used. The following list contains the new techniques implemented to create the system:

- Large searching capacity: search in large orders of magnitude were introduced under two principles: search should be highly non uniform and search should provide “insurance” against simple errors.
- Hardware evaluation: the evaluation function was implemented in hardware. As Deep Blue does not need to constantly re-weigh the worth of a particular evaluation function feature vs the execution time, time to execute the evaluation function is a fixed constant.
- Enhanced evaluation software: the evaluation is done using hybrid software/hardware search. The software search is extremely flexible and can be changed as needed while the hardware search is parameterized.
- Improved search software: parallelism with over 500 processors was introduced to make the tree search.
- Extended book: an extended opening book was made by hand to improve Deep Blue’s performance.

Key Results

The following conclusions were achieved on this paper:

- The success of Deep Blue was not the result of one factor, but the integration of large search capability, non-unifor search and a complex evaluation function.
- The addition of an external FPGA can make the hardware search and evaluation more efficient.
- The selection of an opening book on the match situation and the previous experience playing with a color.
- The selection of different decisions during the implementation of the search function, evaluation function and opening books might lead to better results.