

Paper Summary: Deep Blue

I chose that paper because when this happened I was a kid and was absolutely amazed with that achievement.

Summary

The Deep Blue computer chess system defeated world chess master Gary Kasparov, back in 1997. The main contributors to this success included a single-chip chess search engine, a massively parallel system with multiple levels of parallelism, a strong emphasis on search extensions, a complex evaluation function, and effective use of a Grandmaster game database.

The system improved over its predecessor that lost a year ago, in several areas. It used updated and more efficient hardware, higher number of chips, software tools for better debugging and match preparation, and finally new evaluation function. A thorough description of the hardware is provided with the system being designed for heavy parallelization and being organized in three layers, a master processor, his workers (processors) and the chess chips which act as leaves to the workers for searching the last levels.

Deep Blue design, being large and complex had to deal with new challenges. It required large searching capacity (orders of magnitude larger compared to previous systems), hardware evaluation function for speed, hybrid software/hardware search and massively parallel search. The searching capability in particular, follows the principle of high non-uniformity and insurance against simple errors.

In terms of hardware, a critical component is the chess chip, consisting of three parts, the move generator, the evaluation function, and the search control. Several efficient techniques are applied on these functions.

The software part of the search is called "dual credit with delayed extensions" and is designed based on specific chess related principles. For the credit generation of nodes a large set of mechanism is applied.

The simple part of search is performed in hardware due to its speed but it cannot get very complicated.

Parallelization is critical part of the architecture with 30 nodes each one controlling 16 chess chips. There is also centralized control. Certain conditions need to be satisfied to make parallelism possible and optimal though.

Search being a critical operation needs to deal with some major issues such as load balancing, master overload and sharing between nodes.

The Deep Blue evaluation function is essentially a sum of feature values, either static or dynamic. Initialization of the feature values is done by the evaluation function generator.

Some additional techniques that were used, was the opening book, the extended book, the endgame databases and the time control.

As a result, the combination of large searching capability, non-uniform search and complex evaluation function provided a successful system that managed to beat the world chess master. The authors claim that there are several areas for improvement and alternative design choices to be followed.