Deep Blue

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A Summary

Deep Blue is a computer chess system, developed by IBM in the mid 1990s. It received special attention and praise as it was the first artificial system which was able to defeat the then world chess champion Garry Kasparov in a regulated official 6 game match in 1997.

The success of the Deep Blue system was due to years of updating and building up of new features on earlier systems. The final Deep Blue system is actually Deep Blue version II which was built upon Deep Blue version I, which had lost to Garry Kasparov in 1996. The analysis from failure of Deep Blue I extensively helped in creation of final Deep Blue version. Deep Blue I in turn was a result of extensive enhancement on chess Engine called Deep Thought which was originally developed at Carnegie Mellon University in 1980s.

The major factors which contributed to Deep Blue's success include its massively parallel architecture, Hardware based Evaluation function, Hybrid software/hardware search, vast database of good chess moves including Opening book, End Game book and extended book.

The system is composed of a 30 processor and 480 single chip chess search engines. This parallel system architecture helps in searching chess game tree in parallel including evaluating tree node values in parallel thus increasing efficiency. This parallel architecture enabled Deep Blue to reach searching speed from 100 million positions per second to 200 million positions per second depending on the state of the game. This much speed of searching was unprecedented and thus massive parallelism played a major role in Deep Blue's success.

Deep Blue's evaluation function which evaluates the goodness of a chess move/ chess board situation at a time is mainly hardware based. This made the system more efficient as hardware implementation of evaluation algorithm is much faster than software based evaluation algorithm, because in hardware evaluation time to execute the evaluation function is constant. But, the drawback is that it is not possible to add new features to hardware evaluation functions easily.

This hardware evaluation function is implemented in the Deep Blue chip and could be categorized into fast and slow evaluation functions. Fast evaluation is used for computing easily computed evaluation terms such as "piece placement" value. The slow evaluation scans the chess board extensively, computing values for chess concepts such as square control, pins, king safety, pawn structure and other strategies and tactics. The features recognized in both slow and fast evaluation functions have programmable weights to create the final evaluation value.

The Deep Blue search combines a software search implemented in compiled C code on general purpose CPU, with a hardware search, encoded on silicon on the chess chip. The software search is extremely flexible while hardware search is parameterized but mostly fixed. The switching from hardware search to software search and vice versa is possible and is done based on the situation of the game. The term "Searching" here, means searching the game search tree using the techniques such as quiescence search, iterative deepening and transposition tables. Parallel searching is exploited both at hardware level and software level using parallel search algorithms.

As far as the good moves databases are concerned, the opening book consisted of approx 4000 positions built with the help of Grandmasters. This book included tactically complex openings and positional openings. In absence of information in opening book, extended book was used which was created by analyzing past games played by grandmasters and reruns of earlier games and marking best possible moves for a situation. These databases played a crucial role in reducing the complexity of searching.

Thus, success of Deep Blue was due to many features as presented above. But, there were still many improvements possible such as better parallel search, more flexible hardware evaluation function and addition of better pruning mechanism.