

Research Review of the Paper: Deep Blue

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1 Paper Review

The paper describes the deep blue system, developed at IBM. This system beat the world chess champion Garry Kasparov in 1997. The Deep Blue II is an enhanced chess chip designed by IBM and was an improvement of Deep Blue I, which lost to Garry in 1996, the redesign on the chip had a new evaluation function with over 8000 features (an improvement of 1600 features); a hardware repetition detection; a number of specialized move generation modes; and some efficiency improvements that increased the chip speed to 2-2.5 million positions per second.

The system is designed for carrying out chess game tree searches, Deep Blue would average about 100 million positions per second, for quieter searches the speed would double. In the course of the Garry Kasparov match the chip would also achieve a peak of 330 million positions per second. Some of the algorithms Deep Blue used were; quiescence search; iterative deepening; transposition tables; and NegaScout.

By combining the Software search with the specialized hardware Deep Blue had a special chip with three parts: a move generator; a specialized evaluation function; and a search control. Allowing the search algorithm run as a parallel algorithm greatly optimizing its performance. The search algorithm is a selective search called "dual credit delayed extensions, and its based on a number of principles: extend, or force the pairs of moves; forced moves are expectation dependent; fractional extensions; delayed extensions; dual credit; and preserve the search envelope.

The Deep Blue evaluation function is essentially a sum of feature values, ranging from 8000 different ones, from very simple, such as a particular piece on a particular square, to a very complex. The features can either be static, or dynamic, the static ones are set on the beginning of a search, and the dynamic are scaled with a table lookup, based on the value and type of pieces on the board at evaluation time.

The system also have a lot of extra functionalities: the opening book which is a book with 4000 positions, to help in the decision makings; in the absence of the opening book there is a mechanism called the "extended book", which summarizes the information at each position with a 700,000 entries database; an

engame database which contains all possible chess positions with five or fewer pieces on the board; and a time control mechanism.

The success of Deep Blue was from many factors, the large searching capability, a non uniform search, a complex evaluation function, and also other factors, the tuning of the evaluation functions, endgame databases, and the extended book. The authors suggested many improvements, like the efficiency of the parallel search, the hardware search and evaluation, and the improvement of the pruning mechanisms. And also the evaluation functions were considered incomplete. Yet the system was able to beat the chess world champion of 1997.