

Research Review: Deep Blue II

James Mallett

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This paper discusses the Deep Blue machine. It is the world class chess playing machine that was able to defeat Garry Kasparov in 1997. This specific machine is referred to as Deep Blue II, which was preceded by machines which increased in complexity, starting with ChipTest, Deep Thought 1 and 2 and then Deep Blue I, which lost to Garry Kasparov in 1996.

There were a couple of factors that led to the increased performance that allowed the machine to win in 1997. Firstly, Deep Blue II had a completely redesigned chess chip which had over 8000 features, compared to the 6400 that were available on the chip used on Deep Blue I. New features such as hardware repetition detection, specialized move generation modes and efficiency improvements allow the chip to search 2-2.5 million moves per second. Secondly, the number of chips in the system was more than doubled, and a newer generation IBM SP computer was used to handle the higher processing demands. Lastly, a set of software tools to aid debugging and match preparation were developed.

The machine uses software and hardware searching simultaneously, and uses over 500 processors to perform parallel searching in the game tree, something which had been done before but not to such a large scale. The chips are responsible for running the move generator, evaluation function and the search control, which implements a null-window alpha-beta search.

The software search that is implemented is referred to as "dual credit with delayed extensions" searching, and both the software and hardware using a pruning mechanism call "no progress" which plays good moves for a given side sooner rather than later. The evaluation function used in Deep Blue II featured improvements from the function used in the original Deep Blue, these features include piece mobility, king safety and rooks on files.

The overall system features 480 single-chip chess search engines each capable of the before mentioned search speeds, and includes features from previously designed chess programs such as quiescence search, iterative deepening, transposition tables and NegaScout.

Overall, Deep Blue is able to average roughly 100 million positions per second, reach speeds of close to 200 million in quieter positions and achieve a maximum rate of 330 million positions per second. The parallel search using 24 chips also allows for significant increases in performance relative to single chips, for deep forcing sequences the speedups average around 7 with efficiency of around 30%, and for quieter positions the speedups increased to 18 on average with an efficiency of 75%. Testing the full 30-node system is more challenging, but indirect evidence suggests observed efficiencies of 8% and 12% for tactical and quiet positions respectively, something which can be greatly improved.

Deep Blue also uses an opening book, in which a set of about 4000 positions that Deep Blue performs well in including both tactical and positional openings, and a database of endgames.