

# Deep Blue

This paper sets out to describe the Deep Blue chess computer and provide some reasoning behind the design decisions which went into making it.

Deep Blue is the chess playing computer, created by IBM Research, which famously defeated chess world champion Gary Kasparov in 1997.

Deep Blue was the culmination of many years of effort by many research teams rather than a spectacular breakthrough moment. Deep Blue built on the successes and failures of previous generations of chess playing computer such as Chip Test and Deep Thought in the 1980's.

Deep Blue introduced previously unheard of parallel processing capabilities allowing it to search deeper and faster than any previous computer. Deep Blue's hardware architecture involved 30 processors each with 16 specially designed chess chips (480 in total). This enabled Deep Blue to search up to 300 million positions a second during the 1997 contest with Kasparov.

Fundamentally Deep Blue relied on the same algorithmic techniques as previous generations of chess machines such as MiniMax with AlphaBeta Pruning, Iterative Deepening, Transposition Tables and NegaScout. However Deep Blue's capacity for massive parallel processing created new challenges and opportunities for the research team.

At the heart of Deep Blue lies the Alpha Beta algorithm.

The evaluation function was implemented at hardware level in the chess chips. The evaluation function could consider up to 8000 features in deciding the value of a game state.

The search function was implemented in both the hardware and software. The software search performing the upper levels of the search before handing over to the hardware search for the lower levels. The control of massively parallel searches across the 30 processors and 480 chess chips using both software and hardware searching was one of the unique features of the Deep Blue system although the authors of the report feel that this is an area of performance that could have been improved upon with further research,

The software search used by Deep Blue was a revision of the AlphaBeta algorithm which caters the specifics of chess strategy, namely forced moves, this version of AlphaBeta was named Dual Credit algorithm and was unique to Deep Blue.

The hardware search was performed on the chess chips. These chips performed fixed depth null-window searches and quiescent searches in mid-game positions.

In addition to this Deep Blue relied upon databases of chess moves such as openings and end games specifically created for it by grandmasters in order to play the Kasparov match.

The report concludes that the success of Deep Blue was not down to any single breakthrough or factor with the massively parallel search capability, the evaluation function and search functions and chess game databases all contributing. The authors also suggest areas for improvement and further research such as the control of massively parallel search and the use Field Programmable Gate Arrays to modify the evaluation function.