

## Deep Blue by IBM Watson Team: A Brief Summary

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Authors in this paper describes the Deep Blue System which in fact was the machine that defeated then-reigning World Chess Champion Garry Kasparov in a six-game match in 1997. The development of this system is the result of years of researching in building a world-class chess machine.

Deep Blue was developed at IBM Watson Research Center in the mid-1990s and was based on prior chess machines like ChipTest and Deep Thought whose research and development took place at Carnegie Mellon University in the 1980s. In 1989-1990 part of the Deep Thought team moved to IBM where continued the effort to build a world-class chess machine. First result of this effort was Deep Thought 2, also known as Deep Blue prototype. There are two versions of Deep Blue, the one which lost to Garry Kasparov in 1996 called Deep Blue I and the one which defeated him in 1997 called Deep Blue II and whose improvements were made from deficiencies observed during the first match versus Garry.

The machine is a massively parallel system designed to carry out chess game tree searches. The system is composed of a 30-node IBM RS/6000 SP computer and 480 single-chip chess search engines, 16 chess chips per SP processor. Each one of these chips having a search speed to 2-2.5 million positions per second.

Deep blue uses a three-layer search, designating one SP processor as master and remaining 29 as workers, master searches the top levels of chess game tree and then distributes "leaf" position to the workers for further examination. The workers repeat the process carrying out additional few levels of search then distribute their leaf positions to the chess chips, which performs the last few levels of the tree-search. This way the systems is capable of processing multiple branches of search at the same time, I mean in parallel. The chip used in this machine divides into three parts: the move generator, which is in charge of generating moves in an efficient way following a reasonable order, the evaluation function which is composed of a fast and a slow evaluation where first one is preferred when an approximation is good enough and by last the control search which basically runs a null-window alpha beta search.

Evaluation function used in Deep Blue is a really complex one, it uses roughly 8000 different patterns. Features ranges from very simple to very complex and a number of these features were added after the first match versus Garry where researchers observed certain problems.

The success of Deep Blue relies not only in one factor but many, it was achieved thanks to good chess-dedicated hardware, efficiently implemented algorithms, complex evaluation functions, a big grandmaster game database, among others. Deep Blue team used what they considered more feasible and efficient in that moment, leaving many alternatives unexplored, so that further exploration in chess game playing is more than possible.