

Research Review

The goal of the Deep Blue project was to defeat a Chess Grandmaster in tournament play. The project was a multi-year effort to create a world class chess machine. There are two Deep Blue machines: 1) Deep Blue I which was defeated by Garry Kasparov in 1996 and 2) Deep Blue II which defeated Garry Kasparov in 1997.

Many factors went into the success of Deep Blue II in 1997:

- a single-chip chess search engine,
- a massively parallel system with multiple levels of parallelism,
- a strong emphasis on search extensions,
- a complex evaluation function,
- effective use of a Grandmaster game database.

The history of Deep Blue began at Carnegie Mellon University in 1980 with ChipTest and Deep Thought. Later Deep thought 2 (Deep Blue I prototype) was developed at IBM T.J. Watson Research Center by Joe Hoane, Murray Campbell and Feng-hsiung Hsu. Every iteration included more chess engines, better evaluation hardware, new tools for evaluation tuning and visualization. The chess chips allowed Deep Blue to search 2 to 2.5 million chess positions per second and supported 8000 features. Deep Blue used many technics like quiescence search, iterative deepening and transposition tables. Deep Blue performed massively parallel search with its 500 processors. Search was performed in software as well as hardware. Software search explored tree near the root while hardware search explored tree near leaves.

The evaluation function implemented in the Deep Blue chip is composed of a “fast evaluation” and a “slow evaluation”. This is a standard technique to skip computing an expensive full evaluation when an approximation is good enough. The fast evaluation, which computes a score for a chess position in a single clock cycle, contains all the easily computed major evaluation terms with high values. The slow evaluation scans the chess board one column at a time, computing values for chess concepts such as square control, pins, X-rays, king safety, pawn structure, passed pawns, ray control, outposts, pawn majority, rook on the 7th, blockade, restraint, color complex, trapped pieces, development, and so on. The search control portion of the chip uses a number of state machines to implement null-window alpha-beta search. The advantage of null-window search is that it eliminates the need for a value stack, simplifying the hardware design. The disadvantage is that in some cases it is necessary to do multiple searches, for example when an exact score is needed.

In conclusion, many factors contributed to the success of Deep Blue in 1997. The most critical of these factors were large search capability, non-uniform search and complex evaluation function. Based on project design, factors should be determined that will make the most impact and contribute to the overall success of the project.