Research summary on Deep Blue

Deep Blue is a computer based chess system that defeated the then World Chess Champion Garry Kasparov in a series of six matches in 1997. This achievement was the result of considerable research into building a chess engine that is capable of defeating a Grandmaster of the calibre of Kasparov by employing a number of different techniques.

The earlier match with Garry Kasparov in 1996 ended with a loss for Deep Blue and the IBM team went back to the drawing board to make some fundamental changes to the game architecture and returned in 1997 to defeat Kasparov. One of the key changes was an improved chess chip that was able to run a re-designed evaluation function that looked at over 8000 features, compared to 6400 the previous year. The chip also included efficiency improvements that boosted its search speed by 2 to 2.5 million positions per second per chip. The distributed architecture of 480 such chips across 30-nodes of IBM RS/6000SP were able to achieve the maximum sustained speed of searching 330 million positions per second in the 1997 match with Gary Kasparov.

Deep Blue used a hybrid search approach that combined both software and hardware search for maximum effect. The upper levels of the search take place in software and made use of transposition tables for improving search efficiency. The leaf positions are distributed to the chess chips where fixed-depth null window alpha-beta and quiescence search takes place. The host processor distributes the work to chess chips and uses MPI (Message Passing Interface) for communication with other nodes over a high speed switch to run a distributed and parallel search. While parallelism contributed to the outcome, it was the specific enhancements made to the evaluation function between 1996 and 1997 that contributed most to the defeat of Kasparov.

Deep Blue also featured a hand curated opening book of 4,000 positions by Grandmasters Joel Benjamin, Nick De Firmian, John Fedorowicz and Miguel Illescas. The system included the capability to customize the repertoire in an “override” book to suit match situations and last minute corrections. Deep Blue was also able to tap into an extended book of a 700,000 game database by Grandmasters to reference in the case the opening book was insufficient.

An end game database of all positions with 5 or fewer pieces was included on 20-GB RAID disk arrays for online lookup by the Deep Blue system. It was also used during the design of the chess chip to evaluate popular end games and patterns.

By incorporating a hybrid search architecture of both software and hardware search to provide a large search capability, performing highly parallelized distributed search along with an effective evaluation function that considered over 8,000 features, coupled with the knowledge of common openings and historical Grandmaster games, Deep Blue was able to able to achieve an important feat of defeating Kasparov in 1997. While this is a significant achievement, the effort also highlighted aspects that could have been improved to tune the evaluation function further and to achieve greater effective search depth through pruning techniques.

References

Campbell, Murray et al. “Deep Blue.” *Artif. Intell.* 134 (2002): 57-83.