Goals/Techniques

The paper describes Deep Blue computer chess machine that defeated Garry Kasparov, world chess champion, in 1997. Deep Blue was then the latest of a series of chess machines intended to defeat a grandmaster in a tournament.

Deep Blue uses both hardware and software techniques to perform chess game tree searches. Using a three-layer method one processor is set as a master that searches the top levels of the chess game tree. The remaining processors are set as workers and which carry out a few levels of search until they distribute their leaf position to the chess chips, which implement search functions and techniques at a hardware level.

Throughout its interactions, and its predecessors, design choices were made in face of new challenges. Deep Blue's evaluation function is implemented at hardware level thus avoiding the need to reweigh changing the evaluation function feature in face of its execution time. This has the drawback that new features are hard to be added considering time and cost. Deep Blue is massively parallelized being composed of over 500 processors using both software and hardware searches. Deciding when to change from software to hardware search to avoid horizon effects composes a new set of challenges. Software search is flexible and could be changed as needed for complex tasks. Also helping with features that could not be added or changed on the fixed search implemented on the chess chips. Hardware search is fast although simple, to balance the speed of hardware search and complexity of software search chips were limited to perform shallow searches resulting in 4 or 5 ply searches.

Deep Blue evaluation function is composed of a fast and slow evaluation which have programmable weights for easy adjustment. The fast evaluation computes a score in single clock cycle using the major evaluation terms for chess. The slow evaluation scan the chessboard per column computing a score based on broader chess concepts.

An opening book created by hand consisting of about 4000 positions and an extended book created by summarizing a game database were also included to assist Deep Blue in to perform opening moves.

The chess chips are able to compute all the moves simultaneously to get minimum latency while ordering the moves in a reasonable manner.

Results

Deep Blue was able to perform an incredible task defeating Garry Kasparov earning the Fredkin prize. Even with such achievement there still room for further improvements and research. Giving the time constraints on Deep Blue project some features were not used, mainly its extensibility mechanism which would have allowed hardware searches to approach software search complexity. Fine tuning of the many parameters of the evaluation function is also a task worth further research given its difficulty. Although research in the field of parallel systems efforts in this area can still be made increasing the parallel search efficiency used.