

Deep Blue

Introduction

The ultimate chess machine that defeated Garry Kasparov, World Chess Champion, in 1997. The goal was to enhance Deep Blue System into a world-class chess machine. Deep Blue was a massively parallel system designed for carrying out chess game tree searches. The system was composed of a 30-node (30-processor) IBM RS/6000 SP computer and 480 single-chip chess search engines, with 16 chess chips per SP processor.

System, Chip & Search Mechanism

Deep Blue was organized in three layers. One processor was designated as the master, and the remainder as workers. The master searches the top levels of the chess game tree, and then distributes “leaf” positions to the workers for further examination. The workers carry out a few levels of additional search, and then distribute their leaf positions to the chess chips, which search the last few levels of the tree.

The chess chip was divided into three parts: the move generator, the evaluation function, and the search control. The move generator controls the generation of checking and check evasion moves, and allowing the generation of attacking moves. The evaluation function was composed of a “fast evaluation” and a “slow evaluation”. The fast evaluation contains the easily computed major evaluation terms with high values like the “piece placement” value. The slow evaluation computed values for chess concepts such as square control, king safety, pawn structure...etc. The search control implemented null-window alpha-beta search.

There was a large set of mechanisms to assign credit. For example, A singular move is one that is significantly better than all the alternatives, or a absolute singular move is only one legal move with very little risk. The hardware searches took place on the chess chip which can abort a hardware search if the search is taking too long, or is no longer relevant. Depth of search, Depth of offset searches, Endgame patterns encoded in ROM, Number of check moves etc were some parameters for hardware search.

The evaluation function generator, sub-program which was run on the master node of SP system, had a role of adjusting feature values based on the context of the root position. It ran only at the root of the search tree. The opening book consisted of about 4000 opening positions included tactically complex openings. While the endgame databases in Deep Blue includes all chess positions with five or fewer pieces on the board, as well as selected positions with six pieces that included a pair of blocked pawns.

Conclusion

Deep Blue was the culmination of large searching capability, non-uniform search, and complex evaluation function. However, other factors like endgame databases, the extended book, and evaluation function tuning were also involved.