DeepBlue summary

DeepBlue 2 (or simply DeepBlue) is a chess machine developed at IBM, which achieved one of the most significant victories of AI in the 20th century. In 1997 it defeated Garry Kasparov in a six-game match with a score 3.5-2.5.

DeepBlue's algorithm is based on quiescence search, iterative deepening, transposition tables, and NegaScout. It is implemented using a combination of software (C-code) and hardware (specially designed chip called "chess chip"). It can leverage multiprocessor system to perform parallel computations. DeepBlue version which won 1997 matchup was run on 30-processor IBM RS/6000 SP computer with 16 chess chips per processor. This system, depending on the current game situation, is capable of searching 100-200 million positions per second.
It was consciously decided to use highly non-uniform search techniques due to performance considerations. DeepThought, a predecessor of DeepBlue, proved that strong human players search much deeper than algorithms based on the uniform search in reasonable time.

DeepBlue search process is organized in three phases. Master node (processor) runs top-level search then distributes work to child nodes. Child nodes run deeper search and then push search further to hardware chips. Hardware chips run 4-5 plies of search and finally return the result of the evaluation function.

DeepBlue's evaluation function is implemented in hardware, which makes it both very fast and very rigid at the same time. Its value is basically a feature vector sum. Feature space size is about 8k, weights are crafted and tuned by hand. Evaluation function generator function attempts to adjust this model to the current game position by leveraging "dynamic values". These values, however, are calculated only at the beginning of the search and scaled but not re-evaluated in deeper plies.

DeepBlue's move generator attempts to generate potential moves in preferable order, which is critical to be able to gain boost from NegaScout. This idea is somewhat similar to AlphaGo's "beam of high-probability" moves. Both approaches aim to explore potentially best moves first. This results in higher probability to find a good move in limited time.

DeepBlue is capable of leveraging a book of opening moves, as well as endgame databases. Neither one of these played a significant role in the match with Kasparov.

DeepBlue increased an accuracy of the search by using "Extended Book" — a database of ~700k recorded games. It could calculate bonuses/penalties for a move, based on the data from this database. E.g. if this move was recently played by many Grandmasters than this move is more likely to be good. This approach is fundamentally different from AlphaGo, which used data from existing games to train Neural Network.

As seen by its authors, DeepBlue's implementation took quite a few compromises. Possibly significant improvements could be gained from improving parallel search, use of Field Programmable Gate Array (this would allow access from chess chips to external transposition

table, more complicated search control, and additional terms for the evaluation function), run evaluation function generator on child nodes. Nevertheless, DeepBlue proved that Artificial Intelligence can achieve super-human performance in a highly complex challenge such as a game of chess.