

Deep Blue Chess Machine

Ben Steadman

Deep Blue was the first computer chess playing system to defeat a reigning world champion (Garry Kasparov, 1997) in a chess match. It was developed by IBM Research during the 1990's and was actually the second iteration of the Deep Blue system that was successful - the first losing to Kasparov the year before (although it was the first to win a single game).

The Deep Blue project had one main goal - defeat a reigning chess world champion in a championship match.

Techniques/features implemented in Deep Blue:

- Massive parallelisation
 - 30-node IBM RS/6000 SP computer
 - 480 chess chips (16 per SP processor)
- Dedicated chess chips
 - Move generation, evaluation and search
- Complex evaluation function
 - 8000 features
- Grandmaster game database
 - Prior knowledge of move utility
- Adaptive time control

The parallelisation of Deep Blue allowed far deeper searches into a game tree as simultaneous searches could be delegated to slave processors. This allows the host processors to continue computation of other tasks - evaluation, new searches etc. Although complete search of the game tree was still completely infeasible, the massive parallel processing power allowed a much more 'brute force' approach to be taken - giving much greater search depths and speed.

The system utilised both hardware and software search to enable deep searches of game trees. At its core, the software search utilised a depth-limited alpha beta search using the negamax algorithm. It also employed selective search strategies to take into account chess specific tactics such as Extended Forcing. The hardware search performed on the dedicated chess chips was simpler, but very fast. The chips performed a fixed-depth null-window search of the game tree. Deep Blue hardware searches are shallow (4-5 ply) to produce a balance with the more complex and efficient software search. The chips utilise quiescent search and are allowed to search deeper during end game. The two searches combined therefore give search depths of 6-8 on average up to a maximum of 30-40 in certain situations.

The evaluation function uses a sum of feature values technique to evaluate a game state. Deep Blue recognized approximately 8000 different features/patterns (position of particular pieces,

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detection of strategies etc) each assigned a value. The sum of all these values for a given state is its utility. The Grandmaster game database contains information about each position in 700,000 games played by chess Grandmasters (move frequency, strength of players for each move, results of moves, commentary on move strength etc). This is then used as a lookup to influence the moves chosen by Deep Blue - especially during the opening moves.

Deep Blue used two-stage timing for move decisions. As chess has time limitations (i.e. 40 moves must be made within the first 2 hours), searching for each move was cut off at a specific time. In a 'normal' situation, Deep Blue would cut off its search when a time cap is reached and return the best move found so far. The 'normal' time cap is deliberately low to allow a buffer of reserve time for 'panic' situations. If a panic situation is detected (current best move has dropped a lot of points, best move will 'fail-high' etc), the cutoff time is increased to allow further search to be conducted.

The result of all the techniques combined is that Deep Blue was able to defeat chess Grandmaster Garry Kasparov with a score of 3.5 games to Kasparov's 2.5 games in May 1997 .