IBM Deep Blue Research Paper Summary
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IBM's Deep Blue was a chess computer that defeated grandmaster Garry Kasparov in 1997. It was a landmark event in the advancement of the AI in the 20^{th} century. Among the innovations that led to Deep Blue's victory were the following — selective chess search, a complex evaluation function, advances in parallel computing, and the use of opening and closing books. The Deep Blue computer was made up of 30 processor nodes, with 16 single chess chips per node (for a total of 480). Each chess chip was made up of three components : the search control, evaluation function, and the move generator.

The search responsibility was divided amongst all chess chips by a master processor. Taken together, Deep Blue could efficiently search over 2 million positions per second, and a three minute search would reach a full width depth of 12.2. The system implemented many of the concepts introduced in the current AIND module (eg. quiescence search, iterative deepening). It also made use of a concept called transposition tables, which are hash tables containing previously explored game states. This would drastically reduce search time in cases where identical board states were achieved through different move sequences.

Hardware search was used to quickly explore 5-ply (levels) before transferring responsibility to software search. Deep Blue search was selective (non-uniform) — it was performed under a particular set of rules. Priority was given to forcing / forced pairs (FFPs) such as a check, capture, or threat. FFPs were extended two-ply, and a credit generation mechanism was implemented to differentiate isolated FFPs from more complex sequences. The credit generation mechanism was built to recognize concepts such as threats, mating, and influence. A move would be implemented once sufficient credit was established for a particular FFP.

Deep Blue's evaluation function could identify over 8000 patterns and features in the game of chess. The function was split into a fast and slow evaluation. The fast evaluation would calculate a sum of piece values for particular squares on the board. Slow evaluation scanned the board for concepts such as pawn structure, passed pawns, and trapped pieces. Each feature was assigned a value. These values were static in some cases (eg. a particular piece on a specific position of the board). Other values were dynamic, meaning that the value was adjusted based on the presence (or abscence) of other pieces in the game. There were 54 registers and 8096 table entries of values for the evaluation function, the majority of which were tuned manually. The sum of these features was used to make a decision about how to proceed.

In order to simplify decision making at the beginning and end of the game, an opening book and endgame database was made available to Deep Blue. Additionally, a normal time mode (the game required both players to make a sum of 40 moves in two hours) and panic mode were implemented to enforce timely gameplay. Deep Blue was the result of decades of research within AI. The authors highlighted parallel search efficiency, evaluation function tuning, and additional pruning as potential future improvement areas.