Research Review: IBM Deep Blue

The original intent of the IBM Deep Blue team was to develop a world class level chess system. This culminated in 2 systems, one of which lost to World Champion Gary Kasparov in 1996, and one that defeated Kasparov in 1997. The high level approaches taken to accomplish the historical feat included: single chip search engines, taking advantage of parallelism, and using a Grandmaster game database. Some of the more specific approaches and techniques taken include:

Distributed workload

An interesting way of distributing the work in the Deep Blue system that eventually beat Kasparov was by designating a Master node to begin the highest level search evaluation. This would then designate a worker node to evaluate a particular leaf of the search tree. Finally, a chess chip would evaluate the final levels of the tree before reporting it's findings. This distribution of workload was a critical component in evaluating the needed number of moves to compete with a chess grandmaster.

Evaluation Function

The IBM team used a combination of a quick evaluation and slow evaluation to help with search efficiency. Fast evaluation took into account the value and position of a piece along with a few easily calculated features. The slow evaluation takes a column at a time and looks for numerous proven chess strategies that would indicate a greater overall board state for the agent. In both evaluation functions weights are used to give greater significance to certain positions or strategies.

Search - Dual credit with delayed extensions

This selective search technique was tuned to account for a number of useful chess conditions including forcing/forced pairs (*ffp*) moves. This can be a series of moves that a human may make that require corresponding moves for the opponent in order to delay victory for the opponent, or lead to their own victory. This can lead to search explosions as moves are repeated, and this was necessary to be accounted for by the IBM team. They applied strategies such as dual credit, delaying the extension of these *ffp* moves, and only fractionally extending the search tree for these *ffps.*

Opening and Extended Books

As a way of training the Deep Blue system, a set of opening moves was used that was hand crafted by chess grandmasters. This allowed for a beginning state dependent on the opponent style, previous success rates of the opening move and more. Eventually the team extended this to include over 700,000 game opening moves for Deep Blue to use. This helped weigh the moves as more valuable or less valuable in the decision making of Deep Blue.

Results

The result of the work that went into the Deep Blue system and it's many predecessors was obviously the seminal win against grand master Gary Kasparov in 1997. But along the way, the IBM team learned of the many decisions made to enhance search speed and accuracy, that had alternative options that were not fully explored. Search pruning for instance was fully ignored and has the potential for increasing the efficiency of the system.