Research Review

Deep Blue

Murray Campbell, A. Joseph Hoane Jr., Feng-hsiung Hsu

The goal of the team behind the Deep Blue system that was implemented by IBM's Watson to defeat Garry Kasparov in 1997 is obvious: To develop a system that was sophisticated enough to defeat a world-class Grandmaster Chess player. I knew that this had to have been a monumental effort, but I was genuinely surprised as to how big of an effort it was.

Deep Blue was the result of many iterations and attempts of creating a world-class chess playing AI agent. It is made up of a 30-node SP computer, and 480 single-chip chess search engines, with 16 chips per processor, with each node able to communicate with each other. The result is the ability to search 100 – 200 million positions per second, with the overall average for searches longer than one minute sitting at 126 million positions per second. Other features include the ability to execute parallel searching, and a hybrid hardware/software search. In addition, the evaluation function used was actually a sum of roughly 8000 different "patterns" that were each assigned a value and weight.

Deep Blue did use ideas that we had went over in class, such as quiescence search, iterative deepening, transposition tables, and opening/endgame books. But, as expected of an AI capable of beating a world-class champ, there were also a wealth of both features and ideas that was new territory for me, such as:

- Generations of moves separated by category (e.g. evasion, attacking)
- "Fast evaluation" vs. "Slow evaluation", with "fast evaluation" skipping computing when approximation is good enough
- Null-window alpha-beta search
- A software/hardware hybrid search
- Repetition detection
- Time control with a "panic" mode, which was kicked off by time remaining equal to roughly 1/3rd of given time
- Depth of offset searches
- Parameterized flags used to drive search behavior
- Parallel searching
- Non-uniform searching

There were also automated tools used in feature evaluation as well. These tools were used to both create and tune feature functions, with one to weed out "noisy" features that were highly variable, and another to tune evaluation weights.

Ultimately, Deep blue defeated Garry Kasparov in a six-game match with a final score of 3.5 - 2.5. This is not a large margin at all, and without actually seeing the match, I assume they were all very close games. In reading the paper, a few certain things fascinated me, including:

- The time period in which the first chess AI agents were being created – the 1980s!
- The amount of evaluation functions needed – roughly 8000! I can certainly see why automated tools were used for analysis of the evaluation functions.