

Research review

Deep Blue

Deep Blue paper review, it is about chess machine that defeated then-reigning World Chess Champion Garry Kasparov in a six-game match in 1997 by a score of 3.5–2.5. Researchers mainly describe the later Deep Blue system which won in 1997 (there was one which lost in 1996), how it evolved from previous versions and focus on improvements made before final match with G. Kasparov.

Overview

Deep blue is a parallel system designed for carrying out chess game tree searches, it is organized in 3 layers: one of the computer processors is designated as the master, the remainder are workers and there are chess chips.

On average Deep Blue would search through 100 million positions per second where long forcing move sequences exist – tactical positions; for quieter positions, speeds close to 200 million positions per second were typical. It relies on many of the ideas developed in earlier chess programs, including quiescence search, iterative deepening, transposition tables and NegaScout. Search depth could reach 40 ply but this is approximation because it is not possible to directly measure the number, it is based on results of simulating the hardware search.

The hardware search is fast, but is relatively simple in the Deep Blue system configuration. To strike a balance between the speed of the hardware search and the efficiency and complexity of the software search, chess chips were limited to carry out only shallow searches.

One interesting fact, opening book in Deep Blue was created by hand, it consisted of about 4000 positions and every position was checked in overnight runs.

Improvements

Improvements made after chess machine lost in 1996:

- new, significantly enhanced, chess chip was designed. The new chess chip had a completely redesigned evaluation function, going from around 6400 features to over 8000. It also added hardware repetition detection, a number of specialized move generation modes and some efficiency improvements that increased the per chip search speed to 2–2.5 million positions per second. It supports the use of an external FPGA, but Due to time constraints, this capability was never used in Deep Blue
- second major change was to more than double the number of chess chips in the system, and use the newer generation of SP computer to support the higher processing demands thereby created
- development of a set of software tools to aid in debugging and match preparation.

Identified challenges

Because system grew more complex it gave rise to some new or unusual challenges:

- Large searching capacity – previously game tree search dealt with orders of magnitude fewer positions than Deep Blue;
- Hardware evaluation – on one side it is fast on the other it is not possible to add new features and software patches are problematic;
- Hybrid software/hardware search - difficult to know which one to choose; it can lead to horizon effects;
- Massively parallel search – non deterministic, hard to debug; master is overloaded; quiescence search can cause a search to blow up. Limited experimental results to assess its efficiency. In addition the parallel search code was largely untouched between the 1996 and 1997 matches as team was focussed on improving evaluation function after 1996 Kasparov match.