

DEEP BLUE

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History

- Feng-hsiung Hsu, Thomas Anantharaman, Murray Campbell
 - Carnegie Mellon University
 - ChipTest (1985)
 - Deep Thought (1989)
 - IBM Research
 - Deep Blue (1996)

Deep Blue system overview (1)

- Massively parallel system
 - 30-node IBM RS/6000 SP computer
 - 16 chess chips per SP processor
 - Each capable of searching 2 to 2.5 million chess positions per second
 - All nodes had 1 GB of RAM and 4 GB of disk
 - Running AIX 4.2 operating system
 - 480 single-chip chess search engines

Deep Blue system overview (2)

- Three layered architecture
 - One SP processor is a designated master
 - The remaining 29 are workers
 - Lowest layer consists of the chess chips
- Overall search speed could vary between 100 and 330 million positions per second

Several factors leading to success

- Large searching capability
- Non-uniform search
- Complex evaluation function
- Endgame databases, opening book

Searching

- Basically brute-force
 - Minmax with alpha-beta pruning
 - Minimizing possible loss while maximizing possible gain
 - Alpha-beta pruning discards a move if a better move has been found
- Software/hardware hybrid
 - Software search in compiled C code - flexible
 - Hardware search encoded in silicon on chess chips - fast

Evaluation function

- 8000 features
 - Each a recognized pattern – chess knowledge needed
- Team got help from grandmaster Joel Benjamin
- Implemented in hardware
 - Fixed execution time

Endgame databases, opening book

- Opening books
 - Created by hand by 4 grandmasters
 - About 4000 positions
 - Subsets called repertoires was chosen prior to each game
- Endgame databases
 - All chess positions with five or fewer pieces on the board

Conclusion

- Long time effort starting at Carnegie Mellon, ending at IBM Research
- First computer system to win a chess match against a reigning world champion (Garry Kasparov), 3.5 – 2.5, May 1997

Thank you

- Questions, comments?