DEEP BLUE

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Contents

• 1. History
• 2. Deep Blue system overview
• 3. Factors leading to success
  • Searching
  • Evaluation function
  • Endgame databases, opening book
• 4. Conclusion
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?