DEEP BLUE

A paper by Murray Campbell, A. Joseph Hoane Jr., Feng-hsiung Hsu
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?
[Chorus] Deep blue like water (Water), iceberg, don't bother (Nope) Only aim for the slaughter (Yep), blurred out like sorrow (Yep) Put it off 'til tomorrow (Yo), scenarios, less dreamin' (Dreamin') Conjure up more screamin' (Screamin'), paranoia got me tearin' (Tearin') Deep blue like water (Yeah), iceberg

[Chorus] Deep blue like water, iceberg, don't bother Only aim for the slaughter, blurred out like sorrow Put it off 'til tomorrow, scenarios, less dreamin' Conjure up more