

Deep Blue

**IBM's chess playing
program and its
successors**

Overview

Computer Chess

- Difficult Problem
- Holy Grail of Game AI

History

- ChipTest, ChipTest-M
- Deep Thought .01 to II

Technology

- Hardware
- Continuations
- Game Databases

Time Control

- When to panic?

Other Applications

- Extensively reconfigurable

Computer Chess

Difficult problem

- Many evaluations are “unstable”
- High branching factor
- Many useful “features” involve blocks of multiple pieces
- Evaluations difficult for humans

Holy Grail of Game AI

- At first, seemed like brute-force calculation would win easily
- Until 1996, humans reigned supreme

Enter Deep Blue, Winner of the Grail

- Won a game (in six) against world champion Garry Kasparov on February 10, 1996
- Deeper Blue won 3.5 in 6, May 1997

Evolution of Deep Thought

ChipTest

- Weak opening book
- No ELO rating
- Simple heuristic
- Dual-processor chess circuit
- Unoptimized
- Ran on student workstation
- 30,000 positions/sec
- Equipment cost: \$500

ChipTest-M

- Weak opening book
- About 2500 ELO rating
- Added pawn structure evaluator
- Dual-processor chess circuit
- Best workstation possible
- 400,000 positions/sec
- Principal variation singular extensions
- Equipment cost: \$500

Deep Thought .01

- Mediocre opening book
- About 2550 ELO rating
- Self-tuning software evaluation heuristic using 900 test positions
- More sophisticated hardware evaluation
- 500,000 positions/sec
- Dual-processor chess circuit
- Equipment cost: \$5000

Deep Thought .02

- Mediocre opening book
- About 2600 ELO rating
- Self-tuning software evaluation heuristic using 900 test positions
- More sophisticated hardware evaluation
- 720,000 positions/sec
- Two dual-processor chess circuits
- Equipment cost: \$5000

Deep Thought

- Added additional processors to Deep Thought .02
- 2 million positions/sec
- 3 dual-processor chess circuits

Deep Thought II

- Added additional processors to Deep Thought
- 6-7 million positions/sec
- 12 dual-processor chess circuits

Technology

Hardware

- Each hardware chip a complete chess position evaluator
- 20 billion evaluations in 3 min

Continuations

- Intelligently deciding when to deepen the search

Game Databases

- Opening, Extended, Endgame

Time Control

- Balancing time constraints

Time Control

Timed game

- 40 moves in 2 hours

Time Targets

- **Normal:** remaining time divided by remaining number of moves
- **Panic:** one third of total remaining time

Cases for panic

- Drop by 15 points
- Previous move is in fail-low state
- New move in potential “fail high”

Other Applications

Extensively Reconfigurable

- Financial Risk Assessment
- Pharmaceutical Modeling
- Biomolecules
- Molecular Simulations

Very Fast

- Can model many variables
- Main evaluation in hardware
- Fine-tuned in software

References

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