Deep Blue

What is "Deep Blue"?

- Chess playing machine built by IBM in the 1990's.

- 2 versions.

- Deep Blue 1 lost to world chess champion Gary Kasparov in 1996.

- Deep Blue 2 defeated world chess champion, Gary Kasparov on May 11, 1997.

Leading up to Deep Blue

- Chip Test (1985) – Developed at Carnegie Mellon University. Generated 500,000 chess moves per second. North American Computer Chess Champion of 1987.

- Deep Thought (1988) – Developed first at Carnegie Mellon, then at IBM. First chess machine to beat a Grandmaster in tournament play. 700,000 moves per second. North American Computer Chess Champion of 1988.

Leading up to Deep Blue

- Deep Thought 2 (1989) – Developed at IBM. Prototype for Deep Blue. Four improvements over Deep Thought 1: Medium scale processing, Enhanced evaluation hardware, Improved search software, and Extended book. Calculated 10 to 11 moves ahead.

- Deep Blue 1 (1995) - 36-node IBM RS/6000SP computer, 216 chess chips. 50 – 100 million chess moves per second.

Deep Blue 2: The System

- 510 processors: 30 IBM RS/6000SP computer processors and 480 single-chip chess search engines.

- 2 to 2.5 million moves per second.

- Master – Worker system. 1 SP processor (top-level)-> 29 SP processors (mid-level)-> 16 chess chips (low-level).

- Hardware search and Software search.

Hardware Search

- Preformed on Chess Chips. Fast, but simple 4-5 ply (a single player's move) search.

- Recognizes 8000 patterns with assigned values.

- Finite state machines. Simulates chess board.

- Computes all possible moves. Generates captures, then non-capture moves.

Hardware Search

- Evaluation computes a score for each chess position in a given move. 2 types:
  - Fast Evaluation: Uses easily computed chess terms
  - Slow Evaluation: Scans entire board and computes many chess concepts.
  - Ex. Pawn structure
- Chips communicate through high-speed switch to coordinate move-checking.
- Parallel Search Algorithm

Software Search

- Written in C. Attempt to implement human intuition of chess.

- "Dual Credit with Delayed Extensions":
    - Credit is given for forced moves. Kept track for both players in a given move (hence Dual).
    - Credit is built up as search tree is traversed until sufficient credit is made (the Delayed part).

Software Search

- Credit Generation – Complicated set of operations. Chess Chip scores are used here.
- Examples:
  - The more reasonable moves there are, less credit is given to each move.
  - If only one legal move is available, it is given high credit.
  - Threats to high-valued pieces give high credit.
- Moves closer to the root of the search tree have more credit than those further down the tree.

Software Search

- No Progress - Play a good move as soon as possible.

- Quiescence Search – Searches only "interesting" positions.

- Alpha-beta Pruning – Stops evaluating a move in the search tree when it finds a move that is worse than its previously examined move.

  - Minimax algorithm – recursive algorithm that assigns values to each players' move, makes the move that puts your opponent in the worse possible situation.

Other Stuff

- Open Book – 4000 opening moves that Deep Blue plays well on.

- Extended Book – 700,000 Grandmaster matches

- Endgame Database – All positions with 5 or fewer pieces.

- Time Control – Normal Time (total time left/number of moves left) and Panic Time (1/3 of Normal Time).

Works Cited

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