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.
Leading up to Deep Blue


Leading up to Deep Blue


- **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
