

--Overview

Deep Blue is a computer chess system which was developed in 1997

--History and Current state

Deep Thought was the first computer chess system to beat a chess grandmaster.

Deep thought 2, which acted as the prototype for Deep Blue, was an improved version of Deep Thought by utilizing multiple chess engines, enhanced evaluation hardware with more RAM etc.

Deep Blue I was based on a single chip search engine and its shortcomings were improved in Deep Blue II.

Deep Blue II had an enhanced chess chip which increased the features for evaluation function, added hardware repetition detection, a number of specialized move generation mode and increased search speed.

--System overview

Deep Blue System is composed of a 30-node (30-processor) IBM RS/6000 SP computer and 480 single-chip chess search engines, with 16 chess chips per SP processor.

The chess chips in Deep Blue are each capable of searching 2 to 2.5 million chess positions per second, and communicate with their host node via a microchannel bus.

Deep Blue is organized in three layers. One of the SP processors is designated as the master, and the remainder as workers.

The master searches the top levels of the chess game tree, and then distributes "leaf" positions to the workers.

Key Components:

The chess chip of the Deep Blue system is divided into three parts: the move generator, the evaluation function, and the search control.

1. The move generator is implemented as an 8×8 array of combinatorial logic, which is effectively a silicon chessboard. A hardwired finite state machine controls move generation.

2. The evaluation function is composed of fast evaluation which skips computations when approximation is good and a slow execution which scans the chess board one column at a time, computing values such as square control, pins, X-rays, king safety etc.

3. The search control portion of the chip uses a number of state machines to implement null-window alpha-beta search.

4. Hybrid software/hardware search - The Deep Blue search combines a software search, implemented in compiled C code on a general purpose CPU along with a hardware search.

The hardware search is that part of the Deep Blue search that takes place on the chess chip. A chess chip carries out a fixed-depth null-window search, which includes a quiescence search.

Main parameters of hardware search are depth of search, depth of offset search, endgame rule assertions etc.

5. Parallel Search - Core features of the parallel search algorithm

includes

- a) Processor Hierarchy – Deep Blue uses a static processor tree, with one SP node controlling the other 29 nodes, which in turn control 16 chess chips each.

- b) Control distribution. Deep Blue uses a centralized control of the parallel search.

- c) Load balancing – Deep blue aborts long-running hardware searches (more than 8000 nodes) and push more of the search into software

6. Evaluation function – The Deep Blue evaluation function is essentially a sum of feature values.

Features can be from simple to complex as well as static and dynamic.

The initialization of the feature values is done by the “evaluation function generator”, a sub-program which was run on the master node of SP system

There are 54 registers and 8096 table entries for a total of 8150 parameters that can be set in the Deep Blue evaluation function.

7. Opening book –The book consisted of about 4000 positions and every position had been checked by Deep Blue in overnight runs

8. Extended book – The extended book in Deep Blue is a mechanism that allows a large Grandmaster game database to influence and direct Deep Blue’s play in the absence of opening book information.

9. Endgame databases – The endgame databases in Deep Blue includes all chess positions with five or fewer pieces on the board, as well as selected positions with six pieces that included a pair of blocked pawns.

Results :

All the above features/technologies resulted in Deep Blue defeating the then reigning World Chess Champion Gary Kasparov in 1997.