Research Review

IBM Deep Blue

Goals

The goal of this paper is to describe how Deep Blue, a chess machine that would ultimately beat a human chess grandmaster (Garry Kasparov), a chess player known for his attacking style was built. It outlines the thought process that went into defining evaluation functions and searching techniques that formed the basis for the design for Deep Blue. Deep Blue I, Deep Thought and other intermediate systems are explained that were designed, compared to and improved to achieve this goal.

Techniques

Several techniques/features are described in this paper that formed the basis of this design.

- Searching techniques like Quiescence Search, Iterative Deepening, Transportation tables, NegaScout and alpha beta pruning.
- Highly selective search is preferred instead of uniform search in order to search much deeper.
- Fast and slow evaluation functions to skip excessive unnecessary computation
- Hybrid software and hardware search. DeepBlue combines software search implemented in C with hardware search implemented on chips. This gives flexibility to add more features or overrides since hardware implementations cannot be modified. Careful tuning of parameters and good strategy for switching between hardware and software search should be implemented.
- Upper nodes are evaluated by software and lower level nodes and leaf nodes by hardware/chips enabling parallel searches.
- Using move stacks for repetition detection. This saves the last 30 moves on a stack and detects if the board chess positions are repeated.
- Using opening which is a collection of opening moves that DeepBlue played well in practice.
- Extended book is a game database with all the move in positions played by grandmasters. These moves or the moves that resulted in success would have bonus points and are preferred over other moves.
- Endgame database is a collection of all chess positions which five or less chess pieces.

Results

This resulted in a system that was able to defeat Garry Kasparov. The system is called Deep Blue and is a combination of software and hardware search and evaluation function/features. The system consists of around 8000 features and was able to search 100 to 200 million positions per second. The performance of this system depends on several factors like the processors, number of chips, evaluation function, features implemented, searching techniques and heuristics.