Research Review

By reviewing the Deep Blue paper, I have learned more searching techniques that can enhance machine performances in game agent field. Deep blue as the first chess machine defeated World Chess Champion and played a significant impact on game agent world. This showed that computer can defeat human in chess. There are multiple factors that contributed to this success. In this review, it will introduce some important tactics and design decisions behind Deep Blue.

Goals/ Techniques introduced:
Techniques that help Deep Blue succeed in the chess champing were:
A single-chip chess search engine:
This single-chip chess move generator dramatically increased search speeds from 500,000 positions per second to 700,000 positions per second of each neighborhood. The chess chip was consisted of three parts: the search control, the move generator, and the evaluation function.

A massively parallel system with multiple levels of parallelism:
The parallel system was designed to carry out chess game tree searches. Deep Blue utilizes the IBM SP Parallel System called MPI, which is a message-passing system that contains all control logic. There are three major factors in parallel search implementation, which are load balancing, master overload and sharing between nodes.

A strong emphasis on search extensions
The search extension allows the machine to reach the maximum depth in software. The search extensions algorithm used in Deep Blue leads to widely varying tree sizes for a given search depth. This extends all the way to the hardware, where the complex quiescence search can cause a search to “blow up”. This can lead to severe load balancing problems. The solution used in Deep Blue was to abort long-running hardware searches (more than 8000 nodes) and push more of the search into software. This gives additional opportunities for parallelism. Similarly, jobs on the worker nodes can abort and return their job to the master for further splitting.

A complex evaluation function
The evaluation function not only adjust feature values based on the context of the root position, but also keep tasks organized and manageable by impose some abstraction on lots of distinct feature values. These evaluation function dictate relationship between groups of related feature values.

Effective use of a Grandmaster game database
Grandmaster and other data scientists hand wrote the opening book, which consisted of around 4000 positions, to ensure Deep Blue’s good performance. This book not only included complex openings, but also contained positional openings that Deep Blue played well in the competition. The basic idea is to summarize the information available at each position of a 700,000 game database, and use the summary information to nudge Deep Blue in the consensus direction of chess opening theory.

Results:

- A highly capable parallel system that can calculate 60 billion moves within three minutes, which is the time allotted to each player's move in classical chess.
- Handle large database searches.
- Performs complex evaluation function based on endgame databases and the extended book.

Deep Blue is the first powerful machine chess player. Its development is a big inspiration in many industries. It was an important discovery that push forward the ability of computers to handle different kinds of complex calculations, manage large database searches, and perform great evaluation functions in many fields of science.