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Deep Blue: Research Review

Deep Blue is the chess machine that defeated then-reigning World Chess Champion Garry Kasparov in a six game match in 1997. There were a series of machines that led up to Deep Blue, which are Deep Blue I which lost to Garry in a 1996 match, & earlier efforts in ChipTest and Deepthought the very first machines to beat a Grand Master in a tournament play. The 1997 version is called the Deep Blue II.

After observing several short comings in Deep Blue I the 1996 lost match, multiple new features were improved/introduced. First, a new chip when added improved efficiency with increased per chip speeds of 2-2.5 million positions per seconds of specialized move generation modes. Second, more than double the number of chess chips which use newer(then) SP computers to support higher processing demands. Thirdly, Development of a set of software tools to aid in debugging and match preparation (visualization tools).

Overview of the Whole System:

Deep Blue System is organized in three levels, one of the system is a **master** and rest are **workers**. Master searches the top levels of the game tree and then distributes "leaf" positons to the workers for further examination. Workers after evaluating few levels then distribute their leaf positons to the **chess chips**, which later search the last few levels of the tree. Deep Blue relies on several ideas developed in earlier chess programs including quiescence search, iterative deepening, transposition tables and NegaScout. Apart from these ideas there are several unexplored areas & challenges which Deep Blue II team faced, which pertain to the large searching capacity which needed exploring non-uniformly deeper, similar to strong human players, additionally search should provide "insurance" against

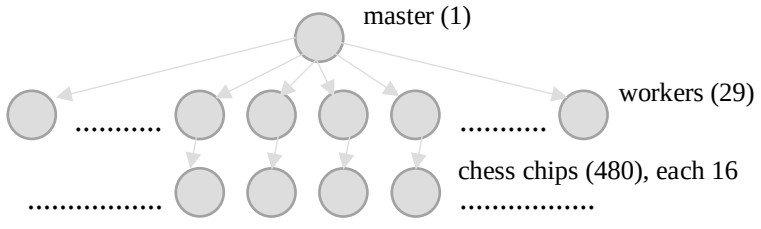

Figure 1.1

sequence of moves to a reasonable minimal depth. Hardware evaluation and Hybrid software/hardware search which led to flexibility decisions. Deep Blue uses a parallel search algorithm with processor hierarchy (seen in **Figure 1.1**), control distribution with centralized control of the parallel search at the master (SP node) since chess chips don't have this functionality. This high level of controlled parallelism is followed with these conditions, **Type I**(PV nodes) **Good Type 2** nodes and **Bad type 2** nodes. Synchronization is implemented at Type 1 and type 2 nodes where the first move has to be evaluated before parallelism is allowed. Evaluation Function is the core component of the next move generation and is composed of essentially a sum of feature values, where initialization of feature values is done by the "**evaluation function generator** ", a sub program that runs on the master SP node and is only run at the master node. To support this massive computation several registers are defined for move and state information (see Pg:74/75 in actual paper). Finally, the most important of all is the "**Opening Book**" for Deep Blue which was created by grandmaster Joel and team, which consists of 4000 positions which emphasize what Deep Blue played well and the "**Extended Book**" a database of moves that helps Deep Blue in the absence of Opening Book.

Summary

The success of such a massive system is attributed to several factors, a single-chip system, a massively parallel system with multiple levels of parallelism, a strong emphasis on search extensions, a complex evaluation function, and effective use of Grandmaster game database. There are many areas of improvements that could be made to this system in parallel search efficiency, while additional pruning mechanisms might have significantly improved the search performance. There were several design decisions made in the progress of this Deep Blue II project based on availability, capacity, time which led to the massive success of this man made AI agent.