# Research review by Folajimi Adekoya
# Selected paper: Deep Blue

The goal of the paper titled Deep Blue by Murray Campbell, A.joseph Hoane Jr and Feng-hsiung Hsu is to describe the Deep blue system, a chess machine that defeated Garry Kasparov the then world chess champion within a six match game in 1997.
The paper also explains some of the reason behind the Deep Blue design decisions.

**Techniques applied by Deep blue**

Deep blue employed large searching capacity by using two guiding principles
I. Highly non-uniform search because strong human players can calculate beyond the depth reachable by a uniform searcher of any conceivable speed.
ii. Search insurance against simple errors, so that all move sequences are explored to some reasonable depth.
Deep Blue evaluation function was implemented in hardware to improve the speed of execution and keep the speed constant.
Deep blue combines software search implemented in a general-purpose CPU and hardware search encoded in a chess silicon chip. The chess chip carries out a fixed-depth null-window search which includes quiescence search while the software search is a new selective search called “Dual credit with delayed extensions”.
Deep blue 2 is built as a massively parallel system with over 500 processors available to participate in the game tree search in parallel. Deep blue parallel search is non-deterministic.
Deep blue has an opening book which has 4000 positions. The openings were chosen to emphasize positions that Deep Blue played well. The openings include tactically complex openings and positional openings that Deep blue handled well in practice.
In the absence of opening book information, a mechanism that allows large Grandmaster game database to influence Deep Blue’s play is available.
Deep blue has a database referred to as the Endgame database. This includes all chess positions with five or fewer pieces on the board, as well as selected positions with six pieces that includes a pair of blocked pawns. The primary source of these databases was the ken Thompson CD-ROMS and Lewis stiller.

**Result**

The paper ascribed the success of deep blue in the match against Garry Kasparov to the design decisions and techniques applied. All of the factors were crucial. Factors such as the use of a large search capability, non-uniform search, complex evaluation function, the decision to implement evaluation function in hardware, parallel search, the use of endgame databases, the extended book and evaluation function tuning. There are also several areas where improvements could have been made such as improving the parallel search efficiency, addition of external FPGA to deep blue to make hardware search and the evaluation function more efficient. The paper encourages further exploration of the alternatives that were left unexplored.