

## Question5

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a) What were the engineering advances that led to Deep Blue's success? Which of them can be transferred to other problems, and which are specific to chess?

- I think reason lead to Deep Blue's success is because it used specialized hardware, including a custom designed chess chip, also used parallel processing and chess-specific strategies to battle with human player. For example, the parallel processing have tons of nodes running at same time, speeding up inside computations, also the pruning algorithms is being optimized so can efficiently reduce number of nodes evaluated during the search tree. Also, they have evaluation function that are fine tuned by professionals allowing better performance with human player.
- I think specialized hardware and parallel processing techniques can be transferred to other problems but the evaluation function that needs chess experts that were specific to chess and don't directly apply to other problems so it cannot be transferred.

b) AlphaZero is compared to a number of modern game-playing programs, such as StockFish, which work similarly to Deep Blue. The paper shows that AlphaZero is able to defeat StockFish even when it is given only 1/100 of the computing time. Why is that? Please frame your answer in terms of search and the number of nodes evaluated.

- I think the reason why AlphaZero is able to defeat StockFish even given only 1/100 of the computing time is because it used a more efficient search engine and use deep neural networks. StockFish only used brute force search and use basic pruning algorithms to evaluate nodes, but AlphaZero used Monte Carlo Search method with neural network and will always make the most promising moves. I think this search allows to reduces the number of nodes need to be evaluated significantly, so will focus on fewer but more important part. Additionally, AlphaZero learns while playing against itself, no need professionals to provide rigorous rules or have to follow certain evaluation function, it more like human made decision and make it able to defeat StockFish with even fewer computing time.