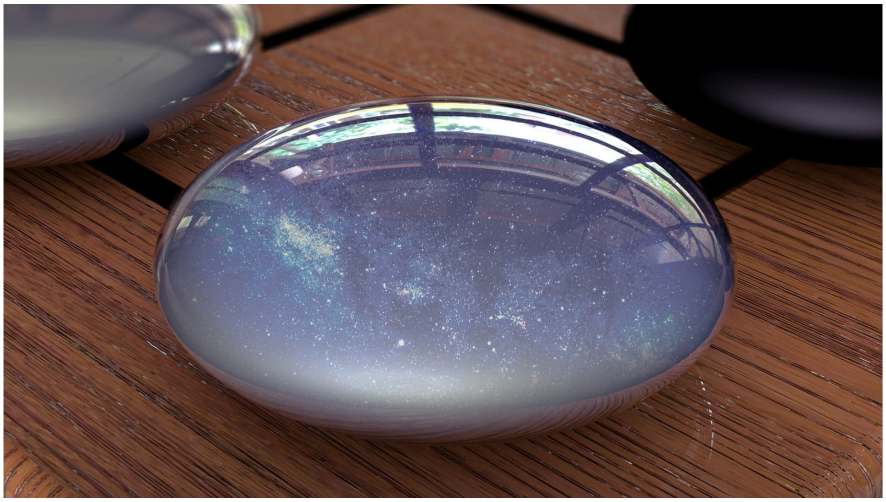
Research

AlphaGo Zero: Starting from scratch

October 18, 2017

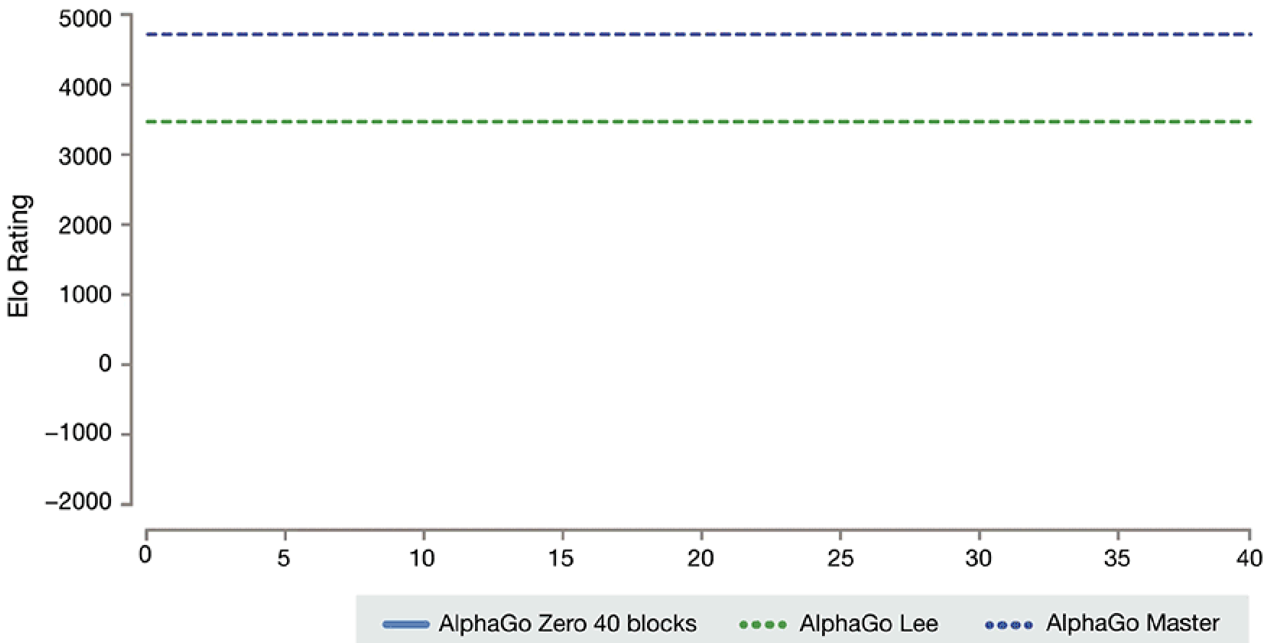


Artificial intelligence research has made rapid progress in a wide variety of domains from speech recognition and image classification to genomics and drug discovery. In many cases, these are specialist systems that leverage enormous amounts of human expertise and data.

However, for some problems this human knowledge may be too expensive, too unreliable or simply unavailable. As a result, a long-standing ambition of AI research is to bypass this step, creating algorithms that achieve superhuman performance in the most challenging domains with no human input. In our most recent paper, published in the journal Nature, we demonstrate a significant step towards this goal.

The paper introduces AlphaGo Zero, the latest evolution of AlphaGo, the first computer program to defeat a world champion at the ancient Chinese game of Go.

to play simply by playing games against itself, starting from completely random play. In doing so, it quickly surpassed human level of play and defeated the previously published champion-defeating version of AlphaGo by 100 games to 0.



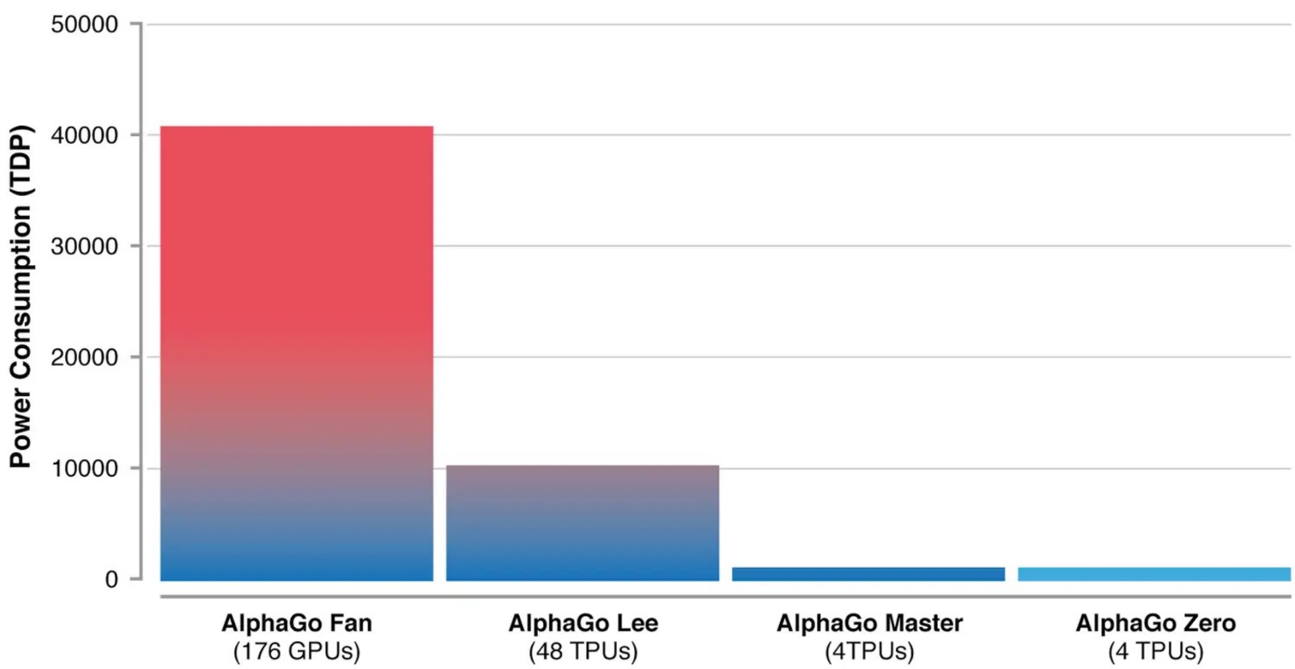
It is able to do this by using a novel form of reinforcement learning, in which AlphaGo Zero becomes its own teacher. The system starts off with a neural network that knows nothing about the game of Go. It then plays games against itself, by combining this neural network with a powerful search algorithm. As it plays, the neural network is tuned and updated to predict moves, as well as the eventual winner of the games.

This updated neural network is then recombined with the search algorithm to create a new, stronger version of AlphaGo Zero, and the process begins again. In each iteration, the performance of the system improves by a small amount, and the quality of the self-play games increases, leading to more and more accurate neural networks and ever stronger versions of AlphaGo Zero.

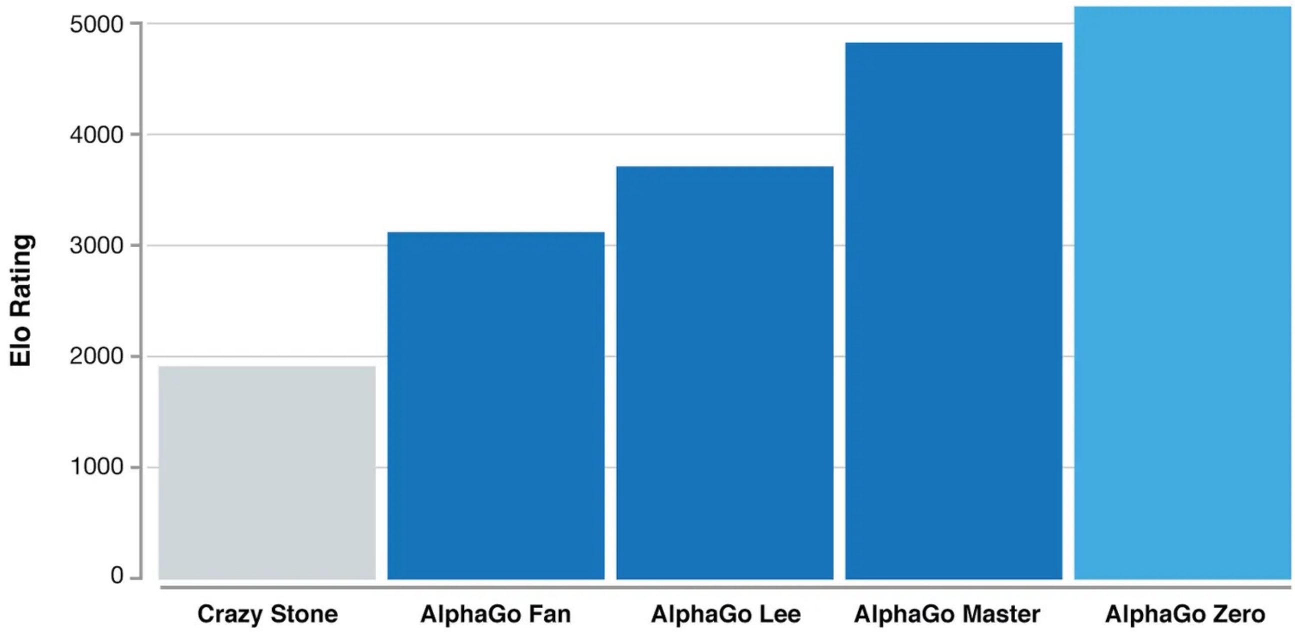
This technique is more powerful than previous versions of AlphaGo because it is no

- AlphaGo Zero only uses the black and white stones from the Go board as its input, whereas previous versions of AlphaGo included a small number of hand-engineered features.
- It uses one neural network rather than two. Earlier versions of AlphaGo used a “policy network” to select the next move to play and a ”value network” to predict the winner of the game from each position. These are combined in AlphaGo Zero, allowing it to be trained and evaluated more efficiently.
- AlphaGo Zero does not use “rollouts” - fast, random games used by other Go programs to predict which player will win from the current board position. Instead, it relies on its high quality neural networks to evaluate positions.

All of these differences help improve the performance of the system and make it more general. But it is the algorithmic change that makes the system much more powerful and efficient.



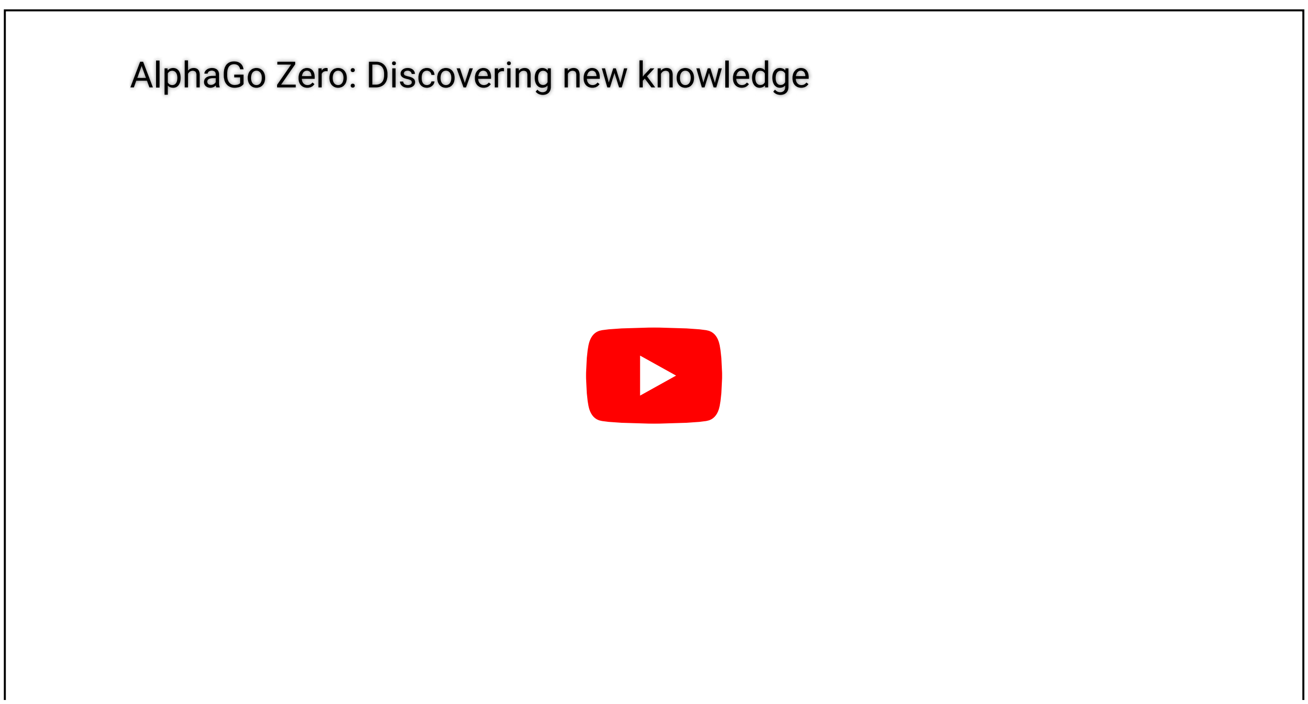
AlphaGo has become progressively more efficient thanks to hardware gains and more recently algorithmic advances



Elo ratings - a measure of the relative skill levels of players in competitive games such as Go - show how AlphaGo has become progressively stronger during its development

Over the course of millions of AlphaGo vs AlphaGo games, the system progressively learned the game of Go from scratch, accumulating thousands of years of human knowledge during a period of just a few days. AlphaGo Zero also discovered new knowledge, developing unconventional strategies and creative new moves that echoed and surpassed the novel techniques it played in the games against Lee Sedol and Ke Jie.

These moments of creativity give us confidence that AI will be a multiplier for human ingenuity, helping us with our mission to solve some of the most important challenges humanity is facing.



folding, reducing energy consumption or searching for revolutionary new materials, the resulting breakthroughs have the potential to positively impact society.

Notes

Read the paper

Read the accompanying Nature News and Views article

Download AlphaGo Zero games

Read more about AlphaGo

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