Where Artificial Neural Networks Outperform Biological Neural Networks

Introduction

Artificial neural networks and biological neural networks both process information, but their strong points lie in different areas. I have discussed several times in past assignments that artificial networks are lacking when it comes to anything requiring nuance (think philosophy, politics, emotions). Additionally, biological neural networks are extremely adaptable, constantly changing connections without the retraining that artificial networks often require. However, artificial networks excel in numerical computation. They are able to run thousands of computations in a time unheard of from a human brain.

Experiment: Neural Network vs. Traditional Computation

With the help of Wolfram Mathmatica, and problem solving using both Google's Gemini and Open AI's ChatGPT, I have structured a simple artificial neural network used on matrix multiplication, to show this.

In this project, an artificial network was trained to perform matrix multiplication using a dataset of 2x2 matrices. I then compared this model to Wolfram Mathematica's built-in matrix multiplication function (to compare execution speed). The results showed that the artificial network was able to perform large-scale matrix operations efficiently, demonstrating its advantage in numerical tasks.

Observations:

The trained artificial network performed matrix multiplication on 1,000 matrices in a fraction of the time required for the human brain to complete the same matrices. While the time needed makes it seem obvious that this model completed the matrices much faster, I went ahead and researched the average time it would take a human to complete the same number of matrices. While I could not find a definite source, it seems to be widely accepted that it will take an average person around 5 seconds to complete a single 2x2 matrix. Multiplying that by 1000 gives me 5,000 seconds, which is about 83 minutes, so just under 1.5 hours. In comparison, the model I created using Wolfram Mathematica completed the same number of computations in about 3.4 seconds. However, because this is actually considered a relatively simple computation, the built-in function in Wolfram beat both, taking only 0.001 seconds. This shows that you do not even need a full neural network to beat out the human brain when it comes to mathematical computing power.

Explanation:

Why is there such a drastic difference in time when it comes to these computations? One explanation is that humans can only perform these equations sequentially. We cannot solve two

matrices at one time. We have to do each one individually. While the human brain can take in extensive amounts of information at once, it cannot perform multiple equations at once. That said, this ability to take in so much information is part of what inhibits the human brain when it comes to these tasks. We simply cannot put 100% of our brain power into a single task as our brains are responsible for so many other functions, and we cannot fully filter out outside distractions or cease the processing of them. In contrast, an artificial network can perform these computations in parallel, with complete focus.

Additionally, artificial networks are also simply more reliable. They are not prone to the same computational mistakes that humans are. Humans will make occasional mistakes, regardless of how experienced or careful they are. This is not true of artificial networks. They are able to execute very precise mathematical functions without getting tired or missing something small and making a mistake.

Finally, while not performed in this specific project, it is important to mention that an artificial network can also pick up on patterns, especially when concerning numeric data, at a much more detailed scale than humans. This is because they are able to analyze so many data points in parallel, without fatigue, as mentioned before. This is especially useful in tasks like medical image processing or in the financial field.

Sources:

- **Wolfram Research**. (n.d.). *Deep Learning Methods*. Retrieved March 20, 2025, from https://www.wolfram.com/language/introduction-machine-learning/deep-learning-methods/
- **Medical Xpress. (2023, January).** *Simple neural networks outperform more complex systems for controlling robotic prosthetics.* Retrieved March 20, 2025, from https://medicalxpress.com/news/2023-01-simple-neural-networks-outperform-complex.html
- **Sophos News. (2017, September 21).** *Man vs Machine: Comparing Artificial and Biological Neural Networks.* Retrieved March 20, 2025, from https://news.sophos.com/en-us/2017/09/21/man-vs-machine-comparing-artificial-and-biological-neural-networks/
- **GeeksforGeeks. (n.d.).** *Difference between ANN and BNN.* Retrieved March 20, 2025, from https://www.geeksforgeeks.org/difference-between-ann-and-bnn/