**Photonics Chips for Machine Learning**

With Machine Learning (ML) algorithms becoming prevalent in almost all computing applications, current computing hardware is struggling to keep up. Photonics chips, which use light instead of electricity to process information, look to be a promising alternative for some hardware components. The main component that is being researched is the hardware accelerator, which is used to reduce energy consumption during matrix multiplications in neural networks. Photonics chips are theorizred to be up to ~10,000,000X more energy efficient than electrical-based accelerators. If they can be scaled, the drastic decrease in operating cost of these neural networks may be able to meet the growing demand.

The primary use case for photonic accelerators is for data centers which manage high volumes of requests to run large neural networks. These data centers could be running a plethora of algorithms such as: robotic object identification, natural language processing, drug development, medical imaging, powering driverless cars, etc. However, all these processes consume a tremendous amount of power to run these algorithms and using photonic accelerators are there to address that issue. Photonic accelerators’ power reduction doesn’t only stand to reduce cost, but also it could minimize the carbon footprint left behind by data centers.

Albeit promising, photonics chips face some key problems when attempting to replace electronic chips. The two main issues, accuracy and miniaturization are being attacked by researchers in hopes of fulfilling the promise of this technology. In 2019, MIT researchers were looking to use a process called “balanced homodyne detection” as an attempt to solve the problem of miniaturization. This process uses homodyne photodetectors to compute matrix multiplication of entire rows of data as opposed to multiple scalar multiplications each done by a Mach-Zehnder interferometer. However, the homodyne photodetectors convert the signal to electricity so there is a possibility for latency and/or power consumption to become a problem. On the other hand, the issue of accuracy appears to be more manageable to overcome. Photonic accelerators produce inherently noisy signals and stronger signals are more robust to that noise, but with stronger signals comes greater power consumption. This may not be all too much of an issue since these photonics chips consume so much less power. For scalar multiplications, there are already photonic accelerators producing comparable accuracy to electronics with ~1,000,000X less power consumption and the same MIT researchers have hopes of achieving even higher efficiency. In 2021, some of the same researchers from MIT (as part of the company Lightmatter) have produced their first photonic accelerator for the market using some the techniques used from their previous research. With more innovation sure to follow, photonics accelerators is an industry to keep your eyes on.

References:

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