Project Title: Nanophotonics for neuromorphic computing and artificial intelligence

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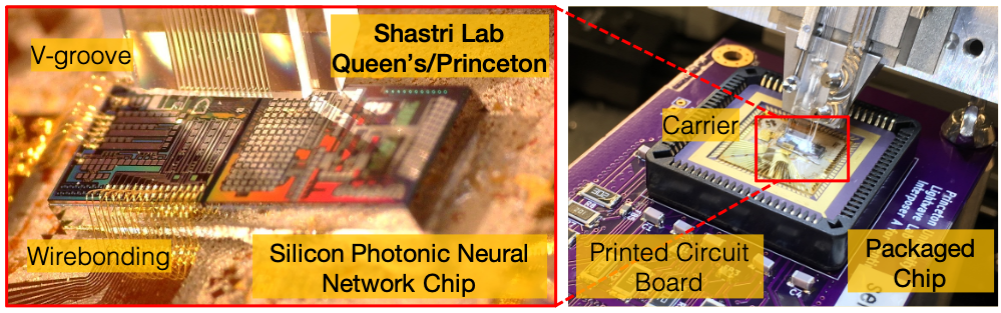
Short description of the project: Artificial intelligence (AI), enabled by neural networks, is intimately present in our everyday lives, for example, for tasks such as face and speech recognition that are easily performed by our phones and computers. As tasks become more complex, such as medical diagnostics of images and self-driving cars, AI algorithms that run on traditional computers put a considerable amount of strain on the computing resources in terms of speed and energy efficiency. As such, there is a global race to develop brain-inspired i.e. neuromorphic computers that can carry-out brain-like processing by mimicking the basic building blocks of brains i.e., neurons and synapses, and by combining these in a scalable architecture to form neural networks.

Photonics (optical physics) provides an entirely new way building such processors that use light instead of electric signals. By combining the high bandwidth and efficiency of photonic devices with the adaptive, parallelism and complexity like the brain, our processors have the potential to be orders of magnitude faster than state-of-the-art electronic processors while consuming less energy. Such chips could potentially extend the bounds of information processing for applications such as scientific computing (nonlinear optimizations) and machine learning (deep learning training and inference)

The goal of this project will be to design and demonstrate neuromorphic photonic processors that can solve tasks such as vector-matrix multiplications in machine learning, partial differential equations (PDE) and optimizations problems, a thousand times faster than in electronics. The open-ended nature of this project has the potential to lead to first-authored journal articles. To learn more about our lab, team, and recent publications visit our lab website.



Our fabricated silicon photonic neuromorphic chip packaged with optical and electrical I/O and mounted on a printed circuit board which can be interfaced with a microcontroller to program the chip with machine learning libraries (e.g. TensorFlow and PyTorch).

Unique opportunities provided to student

- Work with multi-disciplinary team: The student will have the opportunity to work intimately with team of postdoctoral researchers and graduate students from physics, engineering, computational neuroscience at Princeton University, University of Oxford, and University of British Columbia.
- Acquire a unique skillset: The student will receive training in nanophotonics, photonic integrated circuits, and machine learning. As one of the fastest developing areas, the knowledge and skillset acquired in this field, will strategically position the student to either pursue graduate studies or industry prospects (IBM, Xanadu, Apple, HP Labs). See next point.
- Where are my previous students now: Engineer at Apple, Founder/CTO of Luminous computing (a start-up in Silicon Valley backed by Bill Gates and Uber CEO), graduate studies at U. Waterloo etc.

What sort of aptitudes and interests should the student have?

1) Be strongly self-motivated and ability to demonstrated ability to work collaboratively.
2) Desired (but not necessarily required) background in optics, photonics, or neural networks.