A High Performing Fully Tunable Laser Towards Parallel Photonic Neural Networks

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Artificial Neural Networks (ANNs) have become a ubiquitous technology; indeed, their flexibility allows them to excel in a wide range of tasks, ranging from medical diagnosis to language models. Unlike classical algorithms, these networks process information in parallel. Photonics, in particular, shows great promise as a platform for implementing ANNs in terms of scalability, speed, energy efficiency and parallel information processing. We physically implemented the first fully autonomous PNN (photonic neural network), using spatially multiplexed modes of an injection locked large area vertical cavity surface emitting laser (LA-VCSEL). All components of our PNN, including learning are fully realized in hardware using off-the-shelf, commercially available, low energy consumption components, while still achieving >98% accuracy in 6-bit header recognition tasks and promising initial results for the MNIST hand written digit recognition dataset, where we achieve 90% accuracy on average. Crucially, our system performs classification at a high bandwidth of 15 kHz, which is not limited by the LA-VCSEL (GHz bandwidth) and could potentially increase towards the MHz range.