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An end-to-end ML-enabled platform for precision neuroscience

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In situ machine learning data processing for neuroscience probes can have wide-reaching applications from data filtering, event triggering, and ultimately real-time interventions at kilohertz frequencies intrinsic to natural systems. In this work, we present the integration of Machine Learning (ML) algorithms on an off-the-shelf neuroscience data acquisition platform by Spike Gadgets. The algorithms process data in situ on FPGAs in the head unit to extract phase information from neurological data of rodent brain signals to study the behavior of rats. Our goal is to obtain the analytic signal from the recorded EEG in real-time and estimate the phase angle of the analytic signal. We employ hls4ml to synthesize models integrated into the head unit hardware. The first stage of our work was synthesizing a dense MLP, after training it on the rats data, to extract the phase information and implementing it on the FPGA platform. To improve performance, we are further extending our algorithmic approach from simple MLP to use an FFT-based Hilbert Transform. Finally, we have created a more sophisticated model using Discrete Cosine Transforms that performed significantly better and produced more accurate results. Our work enables future exploration of optimized and hardware-efficient algorithms for in situ precision neuroscience.

Focus areas

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