Bio-inspired analog architecture for ultra-low power always-on sensing

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The integration of AI and machine learning into edge devices has rapidly transformed the IoT market from millions of 'things' that sense the world and report back data, to millions of intelligent devices that locally sense the world, analyze the data, and draw insights to make our lives safer and more efficient. The workhorse of these 'TinyML' solutions has been the neural network, initially inspired by the efficient way that our brain processes and stores information but made increasingly artificial for implementation both in digital hardware and in the cloud.

This poster takes a more holistic view of the TinyML signal chain by looking at a novel neuromorphic, analog front-end that focuses the system's resources on relevant data. This bio-inspired 'analyze-first' architecture mimics our brain so that always-on sensing systems spend minimal energy up front in order to save the most power-intensive processing for the most important information. The power- and data-efficient analyze-first architecture is enabled by a new approach to analog computing called RAMP (Reconfigurable Analog Modular Processor). The trainable RAMP incorporates sensor interfacing, analog feature extraction, and an analog neural network into an ultra-low power all-analog processor that can detect unique events from background noise before the sensor data has been digitized, keeping the ADC and downstream processors in sleep mode until they are needed. This analyze-first architecture will enable smaller TinyML solutions with longer battery lifetimes that require less network capability, such as an always-listening audio device with a 10x longer battery life or a predictive maintenance sensor module that processes and transmits 100x less data.