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Doubling the Detection Rate of Ultra-High Energy Neutrinos through a Neural Network Trigger

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This contribution presents the ERC-funded project NuRadioOpt, which aims to substantially increase the detection rate of ultra-high-energy (UHE) cosmic neutrinos for large in-ice radio arrays such as the Radio Neutrino Observatory Greenland (RNO-G, under construction) and the envisioned IceCube-Gen2 project. These detectors consist of autonomous compact detector stations with very limited power (˜20W) and bandwidth (10kB/s) that record the signals from multiple antennas at approx. 1 Gsamples/s. I will present neural networks replacing the threshold-based trigger foreseen for future detectors that increase the detection rate of UHE neutrinos by up to a factor of two at negligible additional cost. As the expected detection rates are low, a neural-network-based trigger will substantially enhance the science capabilities of UHE neutrino detectors, e.g., IceCube-Gen2 will be able to measure the neutrino-nucleon cross-section at EeV energies with more than 2x smaller uncertainty. I will report on an efficient FPGA implementation to run the neural networks under strict power constraints and show lab tests demonstrating the performance under realistic conditions. I will briefly report on a new DAQ system, currently under development, using recent advances in fast, low-power ADCs to run the algorithms in real-time and give an outlook of how neuromorphic computing could further increase power efficiency.

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