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Using End-to-End Optimized Summary Statistics to Improve IceCube's Measurement of the Galactic Neutrino Flux

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Characterizing the astrophysical neutrino flux with the IceCube Neutrino Observatory traditionally relies on a binned forward-folding likelihood approach. Insufficient Monte Carlo (MC) statistics in each bin limits the granularity and dimensionality of the binning scheme. We employ a neural network to optimize a summary statistic that serves as the input for data analysis, enabling the inclusion of additional observables without compromising statistical precision. Achieving end-to-end optimization of the summary statistic requires adapting the existing analysis pipeline to be fully differentiable, specifically by employing differentiable binned kernel density estimation (KDE), computing the test statistic using Fisher information, and incorporating data sampling techniques for neural network inputs. This work will detail the application of end-to-end optimized summary statistics in analyzing and characterizing the Galactic neutrino flux, achieving improved resolution for selected signal parameters and models.

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