Constraining the Number of Neutrino Sources from Events Observed by IceCube using Importance Sampling

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It is well established that observations of high-energy neutrinos provide a direct link to the production sites of high-energy cosmic rays. The IceCube Collaboration has observed a high-energy astrophysical neutrino flux and found strong evidence for neutrino emission from blazar TXS 0506+056. Despite these observations, the number of sources of these neutrinos remains unresolved with current point-like analyses on the HE neutrino flux resulting in the non-detection of neutrinos sources, with the exclusion of the aforementioned blazar [1]. While these non-detections are used to put constraints on source populations, the constraints remain broad.

In this work we marginalise a likelihood function to calculate the most likely number of neutrino sources that produce the observed neutrino sky. This likelihood function contains a spatial distribution of sources and a realistic neutrino source strength distribution described by luminosity with redshift. As the marginal likelihood is a highly dimensional integral, we use importance sampling to achieve convergence, together with variance reduction. We will demonstrate the success of this technique in solving the marginal likelihood on example small scale neutrino skies, thus delivering constraints on the neutrino source population.

[1] IceCube Collaboration, *Search for steady point-like sources in the astrophysical muon neutrino flux with 8 years of IceCube data* (The European Physical Journal C, 2019) p 1-19.