Contribution ID: **52** Type: **not specified**

Conditional invertible neural networks to probe cosmic-ray sources

Thursday, 8 July 2021 20:40 (20 minutes)

To obtain information on the still unknown sources of ultra-high-energy cosmic rays (UHECRs), a combined fit of the observed energy spectrum and depths of the shower maximum can be used, which constrains characteristic parameters of the sources. During propagation from the sources to Earth, UHECRs can experience numerous stochastic processes such that no explicit inverse function, which would describe the source parameters as a function of the measured quantities, can be formulated.
Previously, the high-dimensional space of possible combinations of source parameters has been investigated with Bayesian sampler methods like the Markov Chain Monte Carlo (MCMC), which in general is very computationally expensive. Here, we introduce the application of a new method using deep-learning techniques, the so-called *conditional Invertible Neural Network* (cINN). The network implicitly learns a mapping between the source parameters and the observables from a large set of training data. The backward pass through the trained invertible network then provides the full posterior probabilities including correlations. It needs far less computational resources than the MCMC and can be evaluated in seconds, and therefore the cINN enables extensive rapid tests of the method's accuracy. In this work, we compare the results of the two methods, MCMC and cINN, applied on a simulated scenario inspired by current UHECR measurements of the energy spectrum and the depths of shower maximum distributions. For the cINN, we also evaluate the performance on many test data sets and show that the mean estimates of the source parameters as well as a the widths of the posterior distributions can be described accurately.

Affiliation

RWTH Aachen University

Academic Rank

PhD student

Primary authors: SCHULTE, Josina (RWTH Aachen University); ERDMANN, Martin (Rheinisch Westfaelische Tech. Hoch. (DE)); BISTER, Teresa (RWTH Aachen University); KÖTHE, Ullrich

Presenter: SCHULTE, Josina (RWTH Aachen University)

Session Classification: New Horizons