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Random Forests for determining muon numbers in extensive air showers relative to their primary energy using KASCADE-Grande data

This study presented the development and application of two Random Forest (RF) models to KASCADE-Grande data with zenith angles $\theta < 40^{\circ}$, obtained from the KASCADE Cosmic Ray Data Centre. The aim was to predict the primary energy and correct the muon number for systematic effects on an event-by-event basis. Model training involved KCDC simulations using the high-energy hadronic interaction model QGSjet-II-04. To refine the RF models, we conducted feature engineering on the magnitudes and fine-tuned the hyperparameters. The results enabled us to estimate the number of muons relative to the primary energy in extensive air shower events across the energy range from 10 PeV to 1 EeV. A comparison was made between the experimental results and the expectations from the QGSJET-II-04 model, considering pure protons and iron nuclei, respectively.

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