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Convolutional Neural Network Processing of Radio Emission for Nuclear Composition Classification of Ultra-High-Energy Cosmic Rays (Remote)

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Ultra-high-energy cosmic rays (UHECRs) are the most mysterious particles in the Universe originating from extragalactic sources, which yet rise a couple of fundamental open questions, such as where do they come from, how do they propagate, and how do they reach the energies they exhibit. Due to the very low flux, i.e. one particle per km2 per century at about 1020 eV, UHECRs are detected indirectly from the Earth, through their developed air showers, by modern detection techniques in frame of hybrid and large-scale experiments. Radio detectors have proven to be a competitive method for reconstructing the properties of EASs, such as the shower's incoming direction, its energy, and its maximum development (Xmax).
Concurrently, data science has become indispensable in physics. By applying statistical, computational, and deep learning methods to large databases, researchers can extract insights and make predictions efficiently and accurately, in conjunction with traditional analysis methods.
We introduce a convolutional neural network (CNN) architecture designed to classify simulated CoREAS air shower events to process the radio emission for several types of primary cosmic rays' nuclei. For the classification of the primary particle, we use metrics like Accuracy or MCC to indicate the prediction capability for mass-composition based on data that can be gathered by the Radio Detector (RD) at the world's largest cosmic ray experiment on Earth, the Pierre Auger Observatory.

Type of Contribution

talk

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