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Application of graph networks to a next generation wide-field gamma-ray observatory in the southern sky

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Water-Cherenkov detectors have long proven their importance for the research of high energetic gamma rays in numerous experiments in the Northern Hemisphere.
The Southern Wide-field Gamma-ray Observatory (SWGO) will be the first observatory using this technology in the Southern Hemisphere to observe gamma-ray emission in an energy range of 100s of GeV up to the PeV scale.
The proposed layout will enable observations of the galactic center with a wide field of view and a very high-duty cycle, complementing the Cherenkov Telescope Array (CTA).
The challenge of precision observation lies in rejecting cosmic-ray backgrounds and accurately reconstructing primary energy, using only the air shower footprint captured by the detector.
With new machine-learning techniques advancing in recent times, we propose a novel approach based on graph neural networks (GNNs) to improve background rejection and energy reconstruction for a next-generation observatory.
We selected a GNN-based approach to leverage the capabilities of convolutional neural networks while offering the flexibility needed for event reconstruction across the extensive energy range of SWGO.

In this talk, we introduce the design of the proposed GNN, describe the details of the application to different test configurations of SWGO, and present the obtained results for γ / hadron separation and energy reconstruction.
Comparing our results to current state-of-the-art approaches, we find that our proposed algorithm outperforms hand-designed classification algorithms and observables in background suppression, and improves the energy resolution compared to state-of-the-art methods.

Type of Contribution

talk

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