MAGIC

Science of the Cosmos

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Hybrid Optimization of Experimental Parameters in Space Weather Using Machine Learning

Space weather, driven by solar and geomagnetic activity, significantly impacts satellite communications, power grids, and navigation systems. Accurate modeling and prediction of space weather phenomena require the optimization of experimental parameters, which often involve complex interdependencies and dynamic changes. My PhD research focuses on developing a hybrid optimization approach that integrates machine learning techniques with traditional physics-based models to enhance the precision and efficiency of space weather experiments.

This study explores machine learning methods such as neural networks and ensemble learning to predict solar activity, geomagnetic disturbances, and ionospheric variations. By incorporating optimization algorithms like Genetic Algorithms and Bayesian Optimization, the research aims to fine-tune experimental setups and parameter selection, ensuring adaptability to real-time changes in space weather conditions.

Through this innovative combination of data-driven methods and theoretical modeling, the work addresses key challenges in space weather prediction, such as handling sparse datasets, improving model generalization, and reducing computational overhead. The insights gained are expected to contribute to a better understanding of solar-terrestrial interactions and provide practical solutions for mitigating space weather risks.

Participating in the MAGIC workshop will allow me to connect my research to broader astrophysical phenomena, such as the role of strong magnetic fields in compact stars and the stochastic gravitational wave background. By presenting my findings and engaging with experts, I aim to foster interdisciplinary collaboration and explore potential applications of machine learning in astrophysical contexts.

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