Planetary Recognition and Analysis Model (PRAM):

Abstract

The Planetary Recognition and Analysis Model (PRAM) is a unified machine learning framework designed to improve the detection and classification of exoplanets. With the rapid increase of data from missions like Kepler, TESS, and K2, traditional manual methods of analyzing transit data have become slow and resource-intensive. PRAM addresses this challenge by combining XGBoost gradient boosting and a deep neural network to analyze 27 key planetary and stellar features, including orbital period, transit depth, planetary radius, and stellar temperature.

The model uses advanced feature engineering and data balancing techniques to handle class imbalance and extract meaningful patterns from large, heterogeneous datasets. This approach allows PRAM to deliver high-accuracy classifications with an AUC score above 0.92 across multiple missions, making it more reliable and scalable than traditional single-method approaches.

PRAM provides interpretable confidence scores to help astronomers prioritize candidates for follow-up studies and optimize telescope time. It successfully identifies a wide range of exoplanet types, including Earth-like planets, hot Jupiters, super-Earths, and cold gas giants.

Although the current version focuses on binary classification of confirmed vs. not confirmed exoplanets and transit-based data, PRAM lays the groundwork for future improvements. Planned enhancements include multi-class classification, integration of time-series light curve data, uncertainty quantification, and cloud-based deployment for real-time analysis.

By combining multiple data sources, advanced features, and ensemble modeling, PRAM represents an important step toward fully automated, large-scale exoplanet detection and a valuable tool for the global astronomical community.

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