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Analysis of Kepler light curves using the wavelet transform to discriminate with machine learning the astrophysical nature of the eclipsing object.

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Abstract

The Kepler mission has been the most successful so far in the search and characterization of exoplanets by transit. With this technique, the intensity of light emitted by the star is measured at regular intervals to detect periodically recurring photometric reductions, from which the presence of an object can be inferred. We introduce an approach to analyse light curves by using the Discrete Wavelet Transform (DWT) for exoplanet classification.

Our method consists of four stages. Firstly, light curves are phase folded distinguishing odd and even events. Secondly, a symlet 5 DWT is applied to the resulting curves creating up to 7 wavelet scales. Thirdly, noise filtering is applied to high-frequency scales. Finally, statistical features from the reconstructed curves are extracted by means of *tsfresh*. This information is used to perform supervised classification (LightGBM and AutoSklearn methods) as well as unsupervised statistical learning (t-SNE and UMAP non-linear dimensionality reduction techniques) to discriminate exoplanets from false positives (e.g., binary systems, pulsating stars, etc.). Our approach achieves an accuracy of 81%, beating by $5-6\%$ its non-wavelet counterpart.

Further evaluation of more complex extracted features and enlargement of the data set through simulated curves is required. The present work is a first approach to the identification of the nature of the eclipsing objects in light curves, by extracting features after a wavelet pre-processing.

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