fast machine learning for science

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Enhancing Transit Detection to Uncover Long-Period Exoplanets

Small ($R < 4\,\mathrm{R}_{\oplus}$), long-period ($30\,\mathrm{days} < P$) exoplanets with low equilibrium temperatures are an extremely interesting population, promising insights into planet formation, atmospheric chemistry and evolution, as well as habitability. However, for these planets, the current observing strategy of NASA's Transiting Exoplanet Survey Satellite (TESS) can only capture single transit events in different sectors, if any at all, as the baselines of observation are generally less than 30 days. Moreover, traditional detection methods, like median filtering followed by Box Least Squares, prove comparatively ineffective at finding planets with only a few shallow transits observed.

To address these challenges, we have developed an automated detection pipeline that integrates machine learning-based transit detection with robust vetting techniques to find long-period exoplanets more efficiently. When we identify two or more individual transit events at a star that are sufficiently similar, we assume they stem from the same planet, which limits the compatible periods to a set of aliases and enables cost-effective follow-up observations by the CHaracterising ExOPlanets Satellite (CHEOPS, Swiss Space Office & ESA). We have compared the performance of fully convolutional networks, U-Nets and other architectures in detecting transit signals. We have also investigated the advantages of incorporating features in addition to stellar flux, and the influence of the receptive field on the performance of the models.

When applied to the full TESS data set, we anticipate dozens of newly-detected candidate sub-Neptunes on long periods, providing critical data for investigating the characteristics and distribution of such planets.

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