Identify Transit Signals with Object Detection Algorithm

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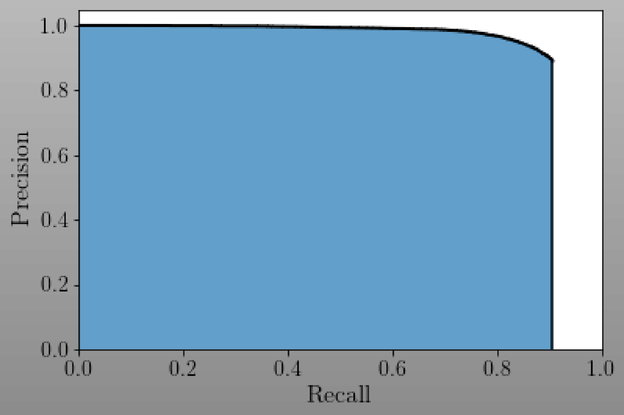
Introduction

Previously, there have been some successful work on 1D CNN-based detection and inspection of transiting exoplanets (e.g., Pearson et al. 2018; Zucker & Giryes 2018; Shallue & Vanderburg 2018; Ansdell et al. 2018; Dattilo et al. 2019; Yu et al. 2019; Osborn et al. 2020; Schanche et al. 2019; Chaushev et al. 2019; Olmschenk et al. 2021).

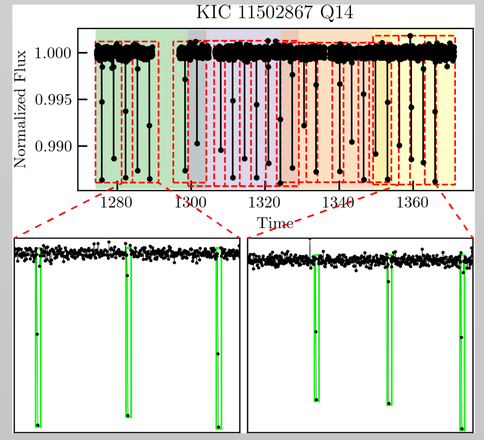
We have developed a transiting signal detection algorithm based on object detection method. Compared with previously 1D CNN, our approach is straightforward and matches human visual intuition. Instead of iterating point-by-point binary classification calculations, our network output the locations and confidences of the transits within the window at one time. Our method also tolerate data gaps and unequal sampling intervals without interpolating data.

Our training data set are based on confirmed Kepler exoplanets and TESS TOIs. After a few epochs, the average precision (areas under the precision-recall curve) converges to ~0.9.

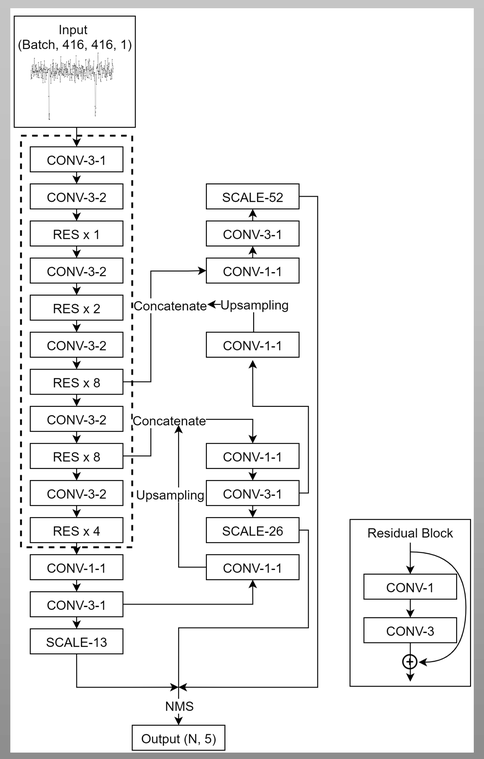


Methodology

Training data preparation



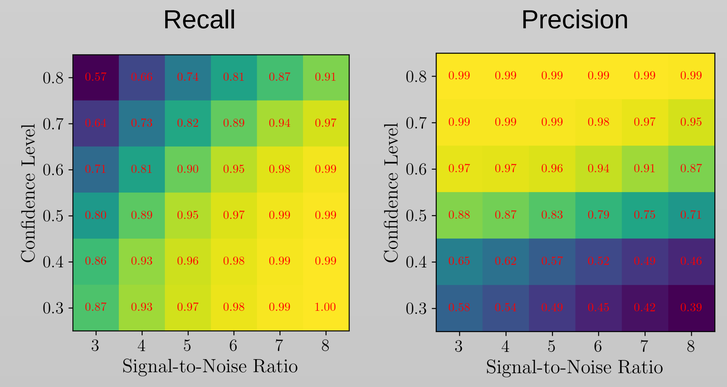
2D object detection neural network



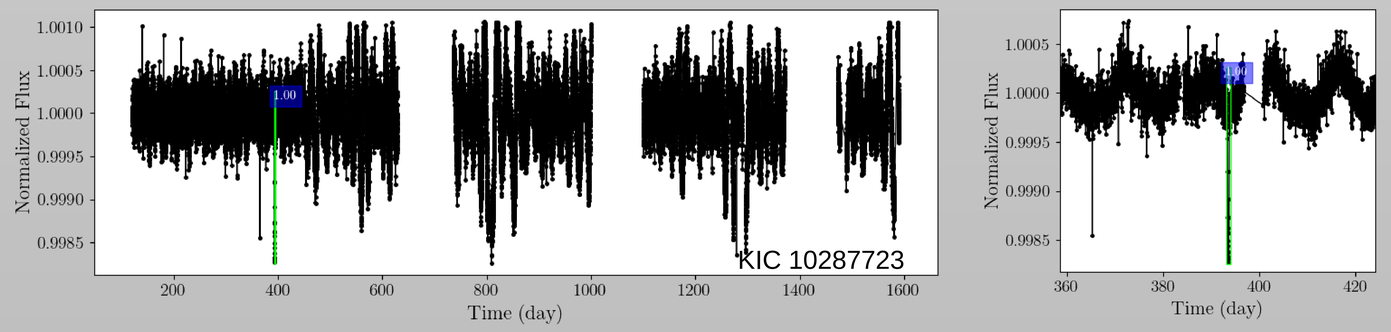
Results and Application

Test on confirmed Kepler exoplanets

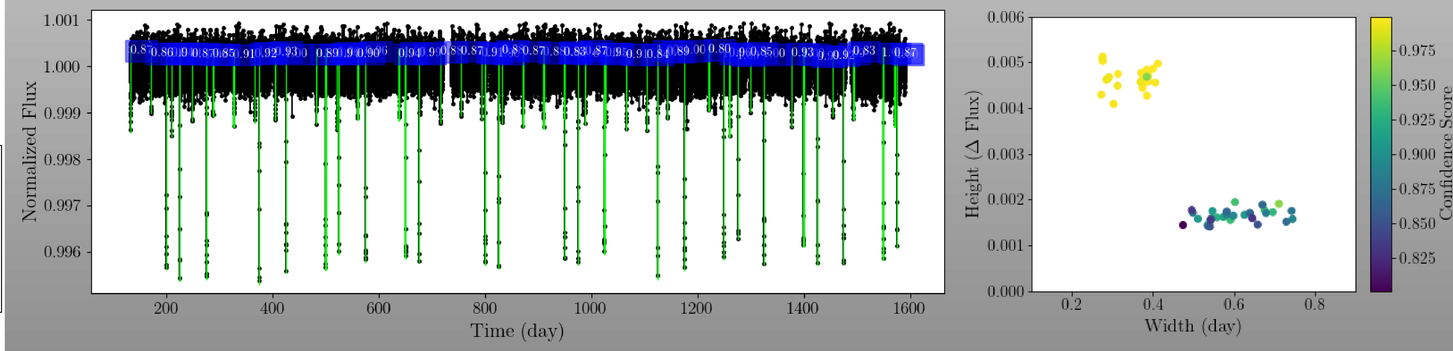
For a single event with S/N>6, we have a good performance that balance recall and precision. Better recall shows the ability to find more transit candidates.



Single transit detection



Multiple transits detection and clustering



This work is public on arxiv: https://arxiv.org/abs/2108.00670 and the code is available on GitHub: https://github.com/ckm3/Deep-Transit