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NEURAL NETWORK ANALYSIS OF MULTI-CHANNEL LIGHT CURVES FOR THE CHARACTERIZATION OF RESIDENT SPACE OBJECTS

Abstract

The constant growing number of satellite launches has led to a congested space environment, increasing the risk of collisions and the proliferation of space debris, thereby undermining space sustainability. In this context, Space Situational Awareness (SSA) is flourishing as an essential field with its tasks which include the recovery of information about the objects orbiting around the Earth commonly defined as Resident Space Objects (RSOs). The observation of RSOs, enabled by active (e.g., radars) and passive sensors (e.g., telescopes), is indispensable for characterizing such objects in terms of their operational life status, orbit, size, shape, etc... Light Curves (LCs), acquired by optical devices as a collection of the visual apparent magnitude during an observation window, represent one of the most powerful ways to enable the characterization of RSOs providing valuable data across all orbital regimes as long as weather and illumination conditions are favorable. The versatility of telescopes allows them to obtain data in single or multiple spectral bands widening the possibility of gathering different useful information about the observed scene. Thanks to this property, LCs can be acquired in multiple channels in the same observation window offering a richer dataset by capturing the variability of the signals across different wavelengths although involving several difficulties about time and visual apparent magnitude discontinuities and overlaps between samples of different channels. The analysis of LCs can be performed via different approaches including techniques which either process the signals in the frequency or time domains or data-driven algorithms whose popularity is rising year after year thanks also to the higher availability of computational resources. In the latter field, neural networks (NNs) represent a powerful tool in signal processing due to their ability to learn complex patterns and adapt to non-linear and noisy data, offering also the prospect of automatically understanding the best features to consider. With this background, this paper proposes an original algorithmic architecture relying on Convolutional Neural Networks for classification of the operative status of RSOs based on multi-channel LCs. In particular, the work aims to distinguish active and inactive RSOs exploiting LCs provided by open-source catalogues which are used to generate the training and testing datasets.