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A Deep Learning Approach to Space Weather Proxy Forecasting for Orbital Prediction

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The dynamics of space objects in Low Earth Orbit are strongly determined by the effects of atmospheric drag. This complex interaction is considered one of the most dominant sources of uncertainty at these altitudes, and is characterised in part by the atmospheric density, a quantity highly correlated to space weather. Current atmosphere models typically account for this via proxy indices such as F10.7, but with variations in solar flux forecasts leading to orbit differences of multiple kilometres over just a few days [1], prediction of these quantities may represent one of the largest limiting factors in drag modelling. This has fundamental implications both in the short term, in the day-to-day management of operational spacecraft, and in the mid-to-long term, in determining satellite orbital lifetime.
In this work, we apply state-of-the-art time series forecasting techniques and deep learning architectures for the prediction of the F10.7 proxy on the days-ahead timescales relevant to space operations. The novel N-BEATS [2] architecture is employed, which has been shown to achieve winning accuracies in the M4 forecasting competition [3], and is compared to operationally available forecasts provided by the ESA Space Weather Service Network [4].

Key words: Deep Learning, Time Series Forecasting, Space Weather, Space Debris

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