MACHINE LEARNING FOR ASTROPHYSICS

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Recurrent Neural Networks for Adaptive Optics parameters estimation

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In the realm of Adaptive Optics (AO), accurately estimating optical and atmospheric parameters such as Strehl Ratio (SR), Seeing (ε), wind speed (ws), External Scale (L0), and the CN2 stratification is crucial. This is particularly vital when aiming to measure these quantities directly from the Wavefront Sensor (WFS) itself. The WFS provides a true measure that directly impacts image quality, as opposed to relying on external instruments which may observe a different optical path. Traditional analytical methods exist for calculating some of these parameters from WFS telemetry data, yet they often fall short when it comes to measuring certain parameters accurately, necessitating approximations that compromise their reliability. Despite the utility of these conventional methods, the advent of statistical approaches leveraging the vast amounts of data generated by WFS telemetry has emerged as a viable alternative in recent years. In this study, we explore a groundbreaking methodology that employs Recurrent Neural Networks (RNNs) within the broader spectrum of machine learning algorithms. These networks utilize data from the WFS (including CCD frames, slopes, reconstructed modes, and actuators commands) to derive estimates of atmospheric and optical parameters. Our findings, which are initially based on simulated data from the LBT telescope's SOUL instrument using PASSATA software and will later extend to real data analysis, are juxtaposed with the current state-of-the-art methodologies to underscore the potential and efficacy of our approach.

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