Studying the limits of long-short term memory neural networks for wavefront prediction

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Abstract

Atmospheric turbulences can cause huge distortions in ground-based telescopes. To overcome this issue adaptive optics has become an essential tool for improving the quality of images. Measuring light aberrations produced by the rapidly changing turbulent atmosphere, it is possible to correct those images in real time. First of all, turbulence is measured using a Shack-Hartmann wavefront sensor, and then following calculations with reconstruction algorithms, the compensation is performed with deformable mirrors. In this work we try to improve previous non-linear wavefront predictors using a long short-term memory (LSTM) artificial neural network, to this end, a series of significant changes are being implemented in the model, in addition to a higher variability into the generated turbulent data from the atmosphere with variable conditions used to train the neural network. The main goal is to predict slopes measurements of a Shack-Hartmann wavefront sensor several frames in advance instead of just one frame as it was made in prior experiments, so that we can analyze how far such a prediction can go. For this purpose, we will also add a change with respect to previous works, the consideration of smaller temporal sequences to check if the learning of the parameters of the model environment is mainly done in the last frames, and thus reduce the amount of unnecessary and possibly inefficient information that encompasses the trained model. The possibility of predicting a certain number of forward values with different successive models trained specifically for each forward position will also be analyzed.

Keywords: Neural networks, predictions, long short, term memory

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