The short-term prediction of Polar Motion and LOD using the Multivariate Multistep 1D Convolutional Neural Networks with Multioutput strategy.

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Abstract

Accurate prediction of Earth orientation parameters (EOPs) is critical for astro-geodynamics, high-precision space navigation, and positioning, onboard autonomous orbit determination, and deep space exploration. However, the current models' prediction accuracy for EOPs is significantly lower than that of geodetic technical solutions, which can adversely affect certain high-precision

real-time users. To address this challenge, deep learning neural networks, specifically the 1DCNN and LSTM models, have emerged as powerful tools. These

models possess the capability to automatically learn complex mappings from inputs to outputs, This feature holds great promise for time series forecasting,

especially for problems with intricate nonlinear dependencies, multivariate inputs, multi-output, and multi-step forecasting. Consequently, these models are

well-suited for our study, where our objective is to predict three parameters.

simultaneously and enhance the short-term prediction accuracy of PM (polar motion) and LODR (length of day rate).

The computational strategy follows multiple steps, first, using the SSA the deterministic time-varying signal of the EOP time series can be more precisely and

reasonably detected and modeled. Then the reconstructed series and its corresponding residuals are used for 1DCNN training and prediction. However, we

develop a Multivariate Multi step 1DCNN model with a multi-output strategy

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using three different scenarios including the Ocean Angular Momentum (OAM), Atmospheric Angular Momentum (AAM), and Hydrological Angular Momentum (HAM), to predict both the deterministic and the stochastic part for (Xp, Yp). Then the best case with fewer errors is chosen to predict the Polar motion and length of day (LOD) at the same time in short term.

The results of two years of prediction experiments based on the EOP 14 C04 series using 1DCNN are compared with LSTM and show that the proposed model can predict both the deterministic and the stochastic parts for the three parameters at the same time with significant improvements in polar motion (PM) and length of day (LOD) for short-term prediction.