Reproduction of Long-term Memory in hydroclimatological variables using Deep Learning Model

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Abstract

Traditional stochastic simulation of hydroclimatological variables often underestimates the variability and correlation structure of larger timescale due to the difficulty in preserving long-term memory. However, the Long Short-Term Memory (LSTM) model illustrates a remarkable long-term memory from the recursive hidden and cell states. The current study, therefore, employed the LSTM model in stochastic generation of hydrologic and climate variables to examine how much the LSTM model can preserve the long-term memory and overcome the drawbacks of conventional time series models such as autoregressive (AR). A trigonometric function and the Rössler system as well as real case studies for hydrological and climatological variables were tested. Results presented that the LSTM model reproduced the variability and correlation structure of the larger timescale as well as the key statistics of the original time domain better than the AR and other traditional models. The hidden and cell states of the LSTM containing the long-memory and oscillation structure following the observations allows better performance compared to the other tested conventional models. This good representation of the long-term variability can be important in water manager since future water resources planning and management is highly related with this long-term variability.

Keywords: Long Short-Term Memory, Stochastic Simulation, Time Scale, Deep Learning

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