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Exploring the Impact of Input Sequence Lengths on Long Short-Term Memory-Based Streamflow Prediction in Flashy Catchments

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Abstract : Predicting streamflow accurately in flashy catchments prone to floods is a major research and operational challenge in hydrological modeling. Recent advancements in deep learning, particularly Long Short-Term Memory (LSTM) networks, have shown to be promising in achieving accurate hydrological predictions at daily and hourly time scales. In this work, a multi-timescale LSTM (MTS-LSTM) network was applied to the context of regional hydrological predictions at an hourly time scale in flashy catchments. The case study includes 40 catchments allocated in the Basque Country, north of Spain. We explore the impact of hyperparameters on the performance of streamflow predictions given by regional deep learning models through systematic hyperparameter tuning - where optimal regional values for different catchments are identified. The results show that predictions are highly accurate, with Nash-Sutcliffe (NSE) and Kling-Gupta (KGE) metrics values as high as 0.98 and 0.97, respectively. A principal component analysis reveals that a hyperparameter related to the length of the input sequence contributes most significantly to the prediction performance. The findings suggest that input sequence lengths have a crucial impact on the model prediction performance. Moreover, employing catchment-scale analysis reveals distinct sequence lengths for individual basins, highlighting the necessity of customizing this hyperparameter based on each catchment's characteristics. This aligns with well known "uniqueness of the place" paradigm. In prior research, tuning the length of the input sequence of LSTMs has received limited focus in the field of streamflow prediction. Initially it was set to 365 days to capture a full annual water cycle. Later, performing limited systematic hyper-tuning using grid search, revealed a modification to 270 days. However, despite the significance of this hyperparameter in hydrological predictions, usually studies have overlooked its tuning and fixed it to 365 days. This study, employing a simultaneous systematic hyperparameter tuning approach, emphasizes the critical role of input sequence length as an influential hyperparameter in configuring LSTMs for regional streamflow prediction. Proper tuning of this hyperparameter is essential for achieving accurate hourly predictions using deep learning models.

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