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A novel artificial neural network for flood forecasting based on deep learning encoder-decoder architecture

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With the rapid growth of deep learning recently, artificial neural networks have been propelled to the forefront in flood forecasting via their end-to-end learning ability. Encoder-decoder architecture, as a novel deep feature extraction, which captures the inherent relationship of the data involved, has emerged in time sequence forecasting nowadays. As the advance of encoder-decoder architecture in sequence to sequence learning, it has been applied in many fields, such as machine translation, energy and environment. However, it is seldom used in hydrological modelling. In this study, a new neural network is developed to forecast flood based on the encoder-decoder architecture. There are two deep learning methods, including the Long Short-Term Memory (LSTM) network and Temporal Convolutional Network (TCN), selected as encoders respectively, while the LSTM was also chosen as the decoder, whose results are compared with those from the standard LSTM without using encoder-decoder architecture.

These models were trained and tested by using the hourly flood events data from 2009 to 2015 in Jianxi basin, China. The results indicated that the new neural flood forecasting networks based encoder-decoder architectures generally perform better than the standard LSTM, since they have better goodness-of-fit between forecasted and observed flood and produce the promising performance in multi-index assessment. The TCN as an encoder has better model stability and accuracy than LSTM as an encoder, especially in longer forecast periods and larger flood. The study results also show that the encoder-decoder architecture can be used as an effective deep learning solution in flood forecasting.