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## Neural ODEs in Hydrology: Fusing Conceptual Models with Deep Learning for Improved Predictions and Process Understanding

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Deep learning methods have repeatedly proven to outperform conceptual hydrologic models in rainfall-runoff modelling. Although attempts of investigating the internals of such deep learning models are being made, traceability of model states and processes and their interrelations to model input and output is not fully given, yet. Direct interpretability of mechanistic processes has always been considered as asset of conceptual models that helps to gain system understanding aside of predictability. We introduce hydrologic Neural ODE models that perform as well as state-of-the-art deep learning methods in rainfall-runoff prediction while maintaining the ease of interpretability of conceptual hydrologic models. In Neural ODEs, model internal processes that are typically implemented in differential equations by hard-coding are substituted by neural networks. Therefore, Neural ODE models offer a way to fuse deep learning with mechanistic modelling yielding time-continuous solutions. We demonstrate the basin-specific predictive capability for several hundred catchments of the continental US, and exemplarily give insight to what the neural networks within the ODE models have learned about the model internal processes. Further, we discuss the role of Neural ODE models on the middle ground between pure deep learning and pure conceptual hydrologic models.