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Editorial: artificial intelligence in hydrology

Nowadays, hydrological systems are becoming increasingly complex owing to the growing interaction between nature and humans at the local scale of river sections, lakes, reservoirs, catchments, etc., to the global scale. There is great demand for the development of models to evaluate, predict, and optimize the performance of complex hydrological systems whose behavior is characterized by a strong nonlinearity. However, traditional approaches can hardly handle this nonlinear behavior; moreover, the analysis of hydrological systems at the large scale, even global, requires dealing with large-volume and real-time data. In recent years, artificial intelligence (AI), especially deep learning, has shown great potential to process massive data and solve large-scale nonlinear problems. AI has been successfully applied to computer vision, machine translation, bioinformatics, drug design, and climate science. AI models have produced results comparable to and even better than expert human performance. It is expected that AI can significantly contribute to hydrology research as well as development.

This special issue is dedicated to presenting to the readership of Hydrology Research some of the latest advances in the field of AI in hydrology. After unbiased and rigorous peer reviews, eight articles were selected to be published in this special issue. Both theoretical and experimental articles are included, covering new and emerging AI methods and models from various challenging problems in hydrology. We hope this special issue can attract more attention from academia and industry to this exciting area.

Roushangar *et al.* (2021) focused on short-term and long-term drought prediction. A hybrid model was developed integrating data preprocessing, permutation entropy, and AI for point and interval predictions of the standardized precipitation index. The proposed approach was studied in northwest Iran and general for application in all areas. The performance of the hybrid model was extensively evaluated with the comparison with single models. The experimental results indicated the high ability of the proposed hybrid model in drought indices modeling.

Xu *et al.* (2021) presented the adaptation and application of the temporal convolutional network in simulating the hourly rainfall–runoff relationship. The optimal hyperparameter combination of the network was investigated at different periods of flood forecast. Two datasets in Jingle and Kuye watersheds were utilized to evaluate the performance of an adapted temporal convolutional network compared with excess infiltration and excess storage model, artificial neural network, and long short-term memory (LSTM). The experimental results showed that the adapted temporal convolutional network outperforms the other approaches with a faster convergence rate and a higher flood forecasting accuracy.

Lu *et al.* (2021) studied the application of red edge band in water body remote sensing extraction. In the study, the GF-6 WFV dataset was considered owing to its high spatial resolution, remarkable number of bands, and wide width. A decision tree model was proposed based on the combined operations of the green band, red band, near-infrared band, red edge 1 band, and red edge 2 band. The extensive experimental results showed the superiority of the proposed decision tree model in terms of extraction effect.

The application of stochastic artificial neural networks in hydrology was studied by Wu *et al.* (2021). An adapted genetic algorithm was employed to calibrate the weights in the model. The developed approach was applied for accurate and real-time hydrological forecasts. A large-scale training dataset was simulated to train the proposed model via a nonnormal multivariate Monte Carlo approach. Finally, a real-time correction method is used to adjust the hydrological forecast.

Baghanam *et al.* (2022) studied the problem of selecting dominant large-scale climate variables, or predictors, in the statistical downscaling of climate models. In their article, a wavelet coherence transform was employed to assess the high common powers and the multi-scale correlation between two time series, i.e., predictand and predictor, as a function of time and frequency. Continuous wavelet transform was employed to identify the potent periodicity in the time series of predictands. Finally, an artificial neural network implements statistical downscaling.

de Moura *et al.* (2022) evaluated the performance of the LSTM network for discharge prediction under changing climate conditions. The LSTM approach was benchmarked with the Hydrologiska Byråns Vattenbalansavdelning (HBV) bucket-type model with two parameterizations. Two insights arose from the article. On the one hand, LSTM had good predictive accuracy

in both the calibration and validation periods. However, LSTM was always less robust than the HBV model. On the other hand, when using the maximum number of years in calibration, the LSTM was robust enough in its application under changing conditions when applied in a condition drier than the one used in calibration.

Nourani (2022) points out that identifying various pixels with similar patterns from satellite images was a reliable method to give an appropriate view of the soil moisture condition of a region. To this end, an AI-based self-organizing map method was employed to classify homogenous pixels using parameters extracted from satellite images. The results revealed the practicability of the self-organizing map clustering method to identify the specific points by which the soil moisture can represent the soil moisture condition.

Finally, Khouakhi *et al.* (2022) studied the AI methods for flood applications. The authors found that flood-related image datasets from social media, smartphones, cameras, etc., were valuable for managing flood risk, e.g., flood extent detection and flood depth estimation. The article discussed the increasing role of convolutional neural networks in flood research and pointed out the lack of open-labeled flood image datasets. The significance of such datasets was also discussed.

We would like to take this opportunity to thank all the anonymous reviewers for their effort and constructive comments, without which this special issue would not have been possible. The same gratitude is extended to the Editors-in-Chief (Prof. Bjørn Kløve and Prof. Nevil Wyndham Quinn) for their integrity and patient guidance. Finally, we thank all the authors for submitting their precious research work to this special issue. We sincerely hope that rejecting any submitted paper will not discourage the authors from carrying out research in this exciting field and submitting the results to this journal.

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