Water level prediction using LSTM and GRU for data-scarce areas

KOLA YUSUFF KAREEM[1], YOUNGHUN JUNG[*1]

[1]*Advanced Science and Technology Convergence, Kyungpook National University*

(a) Purpose of study or research hypothesis

The aim of the study is to predict water level elevations and analyze spatial distribution of gauge stations using LSTM and GRU networks.

(b) Key issue(s) or problem(s) addressed

Implementation of deep learning models in water level prediction for data-scarce regions
Determination of optimal value of hidden layers that gives the best R^2 for both models for the study area
Evaluation of computational cost by comparing the variations of RMSE values of predicted water levels and epochs

(c) Methodology or approach used

Tensorflow - an open source platform, which offers comprehensive libraries and tools for machine learning was used to predict the water levels at downstream of the study area. Daily discharge and precipitation data for 18 years for three stations within the study area were used as input data for the LSTM and GRU. Input data were preprocessed and divided into training, testing and validation datasets. The models were designed to predict daily water level for the next 3 days of lead time for the target station.

(d) Results or conclusions derived from the project

Model topology was created through a trial-and-error approach to obtain an optimal value for the hidden layers (1 - 4 runs; 20 neurons for each layer) using the MAE, RMSE and R^2. Using the same optimal neural network of 3 hidden layers each consisting of 20 neurons, the LSTM and GRU models predicted water level adequately.
Computational cost analysis was assessed by comparing variations of the RMSE values of predicted water levels and epochs correspondingly. RMSE of GRU – predicted values converged to a minimum at an earlier epoch than those of the LSTM. This could be attributed to the simpler architecture of the GRU. The results showed that the GRU gives better results when computational cost is considered while the LSTM can be favourably selected for better predictions.

(e) Implications of the project relevant to congress themes

Deep learning models can be implemented in developing countries that experience difficulty in water resources data management to foster technology transfer and inclusiveness.

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Keywords : Flood forecast, water level, deep learning,, river management, LSTM, GRU