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Implications of Optimisation Algorithm on the Forecast Performance of Artificial Neural Network for Streamflow Modelling

Authors : Martins Y. Otache, John J. Musa, Abayomi I. Kuti, Mustapha Mohammed

Abstract : The performance of an artificial neural network (ANN) is contingent on a host of factors, for instance, the network optimisation scheme. In view of this, the study examined the general implications of the ANN training optimisation algorithm on its forecast performance. To this end, the Bayesian regularisation (Br), Levenberg-Marquardt (LM), and the adaptive learning gradient descent: GDM (with momentum) algorithms were employed under different ANN structural configurations: (1) single-hidden layer, and (2) double-hidden layer feedforward back propagation network. Results obtained revealed generally that the gradient descent with momentum (GDM) optimisation algorithm, with its adaptive learning capability, used a relatively shorter time in both training and validation phases as compared to the Levenberg- Marquardt (LM) and Bayesian Regularisation (Br) algorithms though learning may not be consummated; i.e., in all instances considering also the prediction of extreme flow conditions for 1-day and 5-day ahead, respectively especially using the ANN model. In specific statistical terms on the average, model performance efficiency using the coefficient of efficiency (CE) statistic were Br: 98%, 94%; LM: 98 %, 95 %, and GDM: 96 %, 96% respectively for training and validation phases. However, on the basis of relative error distribution statistics (MAE, MAPE, and MSRE), GDM performed better than the others overall. Based on the findings, it is imperative to state that the adoption of ANN for real-time forecasting should employ training algorithms that do not have computational overhead like the case of LM that requires the computation of the Hessian matrix, protracted time, and sensitivity to initial conditions; to this end, Br and other forms of the gradient descent with momentum should be adopted considering overall time expenditure and quality of the forecast as well as mitigation of network overfitting. On the whole, it is recommended that evaluation should consider implications of (i) data quality and quantity and (ii) transfer functions on the overall network forecast performance.

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