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# A hybrid model coupling extreme gradient boosting model with Gaussian mixture model for streamflow forecasting

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With the increasing water requirements and weather extremes, effective planning and management for water issues has been of great concern over the past decades. Accurate and reliable streamflow forecasting is a critical step for water resources supply and prevention of natural disasters. In this study, we developed a hybrid model (namely GMM-XGBoost), coupling extreme gradient boosting (XGBoost) with Gaussian mixture model (GMM), for monthly streamflow forecasting. The proposed model is based on the principle of modular model, where a complex problem is divided into several simple ones. GMM was applied to cluster streamflow into several groups, using the features selected by a tree-based method. Then, each group was used to fit several single XGBoosts. And the prediction is a weighted average of the single models. Two streamflow datasets were used to evaluate the performance of the proposed model. The prediction accuracy of GMM-XGBoost was compared with that of support vector machine (SVM) and standalone XGBoost. The results indicated that although all three models yielded quite good performance on one-month ahead forecasting with high Nash-Sutclitte efficiency coefficient (NSE) and low root mean squared error (RMSE), GMM-XGBoost provided the best accuracy with significant improvement of forecasting accuracy. It can be inferred from the results that (1) XGBoost is applicable for streamflow forecasting, and in general, performs better than SVM; (2) the cluster analysis-based modular model is helpful in improving accuracy; (3) the proposed GMM-XGBoost model is a superior alternative, which can provide accurate and reliable predictions for optimal water resources management.

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