Runoff sequence feature extraction and prediction using an enhanced sparse autoencoder

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Abstract

For the prediction of the runoff sequence, owing to the non-stationariness and randomness of the sequence, the prediction accuracy of extreme runoff is not enough. In this study, the sparse factor of the loss function in a sparse autoencoder was enhanced using the inverse method of simulated annealing (ESA), and the runoff of the Kenswat Station in the Manas River Basin in northern Xinjiang, China, at 9:00, 15:00, and 20:00 daily during June, July, and August in 1998–2000 was considered as the study sequence. When the initial values of the sparse factor β are 5, 10, 15, 20, and 25, the experiment is designed with 60, 70, 80, 90, and 100 neurons, respectively, in the hidden layer to explore the relationship between the output characteristics of the hidden layer and the original runoff sequence after the network is trained with various sparse factors and different numbers of neurons in the hidden layer. Meanwhile, the orthogonal experimental groups ESA1, ESA2, ESA3, ESA4, and ESA5 were designed to predict the daily average runoff in September 2000 and compared with the prediction results of the support vector machine (SVM) and the feed forward neural network (FFNN). The results indicate that after the ESA training, the output of the hidden layer consists a large number of features of the original runoff sequence, and the boundaries of these features can reflect the runoff series with large changes.Meanwhile, the prediction results of the orthogonal experiment group indicate that when the number of neurons in the hidden layer is 90 and β0 = 15, the ESA has the best prediction effect on the sequence. In particular, the fitting effect on the day of "swelling up" of the runoff is more satisfactory than those of SVM and FFNN. The results are significant, as they provide a guide for exploring the evolution of the runoff under drought and flood as well as for optimally dispatching and managing water resources.

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