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ORIGINAL PAPER

A robust firefly algorithm with backpropagation neural networks for solving hydrogeneration prediction

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Abstract

Hydrogeneration prediction typically has composite structures such as nonlinearity, non-stationarity, and fluctuation, which converts its predicting to be very tough. The applications of backpropagation neural network (BPNN) are very various and saturated. The linear threshold part of the BPNN produces rapid learning with bounded abilities, also the procedure of BPNN causes the slow speed of training. The objective of this study, first, a firefly algorithm (FA) based on the k-fold cross-validation of BPNN has been suggested to predict data for keeping rapid learning and prevents the exponential increase in operating parts. Second, it is to construct on this method to improve an efficient process for prediction problems that can discover efficient solutions at a high speed of convergence. For this purpose, the suggested approach that makes a hybridizing the FA with the robust algorithm (RA), where RA is used to control the steps of randomness for the FA while optimizing the weights of the standard BPNN model. The algorithms were verified on an original dataset of the Himreen Lake Dam. The results display that the regression coefficient, root-mean-square error, mean absolute error, and mean bias error values of the suggested model are 99.86%, 1.87%, 0.91%, and 0.31%, respectively. Furthermore, the performance of the suggested robust firefly algorithm model is better than previously mentioned models in terms of speed and accuracy of prediction.

Keywords Firefly algorithm · Backpropagation neural networks · Prediction problems · Cross-validation

1 Introduction

The experimental models are commonly employed to model hydrogeneration prediction by connecting the actual generation outputs with variant measured climatological data which are environmentally related [1, 2]. Nevertheless, these models' accuracy is doubtful, particularly when related to an extremely inaccurate data [1]. Moreover, this process is expensive and had a shortage in historically observed datasets since it is comparatively fresh. Alternatively, regression models are satisfied in forecasting daily averages of hydrogeneration [3].

In hydropower plant, there are some techniques used to predict hydropower generation such as gray forecasting method [4], support vector machine [5], short-term forecasting model [6], support vector regression [7], Markov process [8]. Artificial neural network (ANN) is the commonly employed methods for prediction. The ANN is employed with several variant case studies to predict the hydrogeneration scheduling [9–20], flow rate of river [21–27], reservoir [28], and irrigation purposes [29]. ANN has also used in modeling for pressure height [30] and winter operational strategies [31]. There is a new method to optimize neural network predicting model of streamflow using a firefly algorithm [32] and maximize hydropower generation [33].

Owing to several defects of ANN relating to the idle rate of training, low speed of convergence, nonlinear mapping ability, etc. Basically, in some neural networks, the speed of training of multiple layer perceptron (MLP) is worse than other networks. Correspondingly, this network has a slow rate of convergence and cannot adapt for solving the complex and nonlinear problems (as the prediction mission of data mining is extremely nonlinear). Besides, MLPs need a strict algorithm for training and are susceptible to overfit the data,

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