Soft Computing
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APPLICATION OF SOFT COMPUTING

Chaotic oppositional-based whale optimization to train a feed forward neural network

Rajesh Chatterjee[1] · Ranapratap Mukherjee[1] · Provas Kumar Roy[2] · Dinesh Kumar Pradhan[3]

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Abstract
The feed forward neural network (FNN) has a significant breakthrough in recent times in solving different real-life complex problems. The success of FNN is primarily attributed to its architecture, the optimization technique used, and the tuning of hyper-parameters to identify different patterns in data. This study tries to find an optimization technique that will play a vital role in an FNN to get better results. Whale optimization algorithm (WOA) is one of the popular nature-inspired optimization techniques used to solve real-time sciences and engineering problems. A new optimization approach namely chaotic oppositional-based whale optimization algorithm (COWOA) is developed in this paper, for the first time, to discuss the FNN problems of four different dataset by integrating chaotic function and oppositional-based learning with WOA. Simulation results are presented to validate the success of the suggested COWOA approach and demonstrate its dominance over basic WOA, chaotic WOA (CWOA), particle swarm optimization (PSO), Adam optimization algorithm (AOA), and stochastic gradient descent (SGD) for both unimodal and multimodal dataset problems. The comparative analysis with other optimization techniques validates its superiority and robustness on four standard dataset of FNN problem. Furthermore, to validate the performance of the proposed algorithm, a statistical analysis is performed. The outcome of the statistical results validates the superiority and acceptability of COWOA over other optimization methods.

Keywords Chaos theory · Feed forward neural network · Whale optimization algorithm · Artificial neural network · Oppositional-based learning

1 Introduction

The intuition of the feed forward neural network (FNN) comes from the collection of neurons found in the human brain that are connected to process a given input. Each neuron receives a set of input and collaborates with many other neurons to yield the desired output. In a similar manner, an FNN (Svozil et al. 1997) is made up of an input layer, one or more hidden layer(s), and an output layer. The set of nodes in each layer can be thought of as a set of neurons available in the human brain. Input layers consist of a number of features available in the input data. In contrast, hidden layers are used to capture the nonlinearity of the data, and the output layer consists of desire number of outputs. The output layer captures the predicted output. Each node performs on a weighted sum of incoming inputs followed by activation. The interesting part of FNN is capturing nonlinearity, a high degree of noise shield, and parallelism. FNN is used across multiple areas of science and engineering like image classification (Zhang et al. 2015), text analysis (Arora and Kansal 2019), time series forecasting (Asadi and Regan 2020), etc.

The effectiveness of FNN comes from the ability to train a given model. A model is well learned when a model can predict a given regression or classification problem with minimum error. Training a model depends on network architecture, proper hyper-parameter selection, and choice of optimization technique to improve the training process and minimize fitness error.

The current study focuses on improving the optimization technique for better learning of the model. The role of an

✉ Rajesh Chatterjee
r.k.chatterjee@umu.ac.in

[1] Usha Martin University, Block Office, At Village Narayansoso, Ranchi - Purulia Rd, near Angara, Highway, Angara, Jharkhand 835103, India

[2] Kalyani Government Engineering College, Kalyani, West Bengal, India

[3] Dr. B C Roy Engineering College, Durgapur, West Bengal, India