METAHEURISTIC ALGORITHMS AND NEURAL NETWORKS IN HYDROLOGY

Edited by
Kuok King Kuok and
Md Rezaur Rahman

Metaheuristic Algorithms and Neural Networks in Hydrology

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CHAPTER 7

MISSING DAILY RAINFALL PREDICTION USING GREY WOLF OPTIMIZER-BASED NEURAL NETWORK

LAI WAI YAN[1], KUOK KING KUOK[1], CHIU PO CHAN[2], MD REZAUR RAHMAN[3], MUHAMMAD KHUSAIRY BAKRI[4]

[1]Faculty of Engineering, Computing and Science, Swinburne University of Technology, Sarawak Campus, Jalan Simpang Tiga, 93400, Kuching, Sarawak, Malaysia.
[2]Faculty of Computer Science and Information Technology, Universiti Malaysia Sarawak, Jalan Datuk Mohammad Musa, 94300, Kota Samarahan, Sarawak, Malaysia
[3]Faculty of Engineering, Universiti Malaysia Sarawak, Jalan Datuk Mohammad Musa, 94300, Kota Samarahan, Sarawak, Malaysia
[4]Composites Materials and Engineering Center, Washington State University, Pullman, WA, United States

Abstract

This research chapter presents the integration of the Grey Wolf Optimizer (GWO) algorithm for training a Feedforward Neural Network (FNN) to address the issue of missing daily rainfall records. A case study was conducted to assess the efficacy and reliability of GWO in overcoming the limitations associated with conventional FNN training algorithms, which often get stuck in local optima. The performance of the developed GWOFNN approach was evaluated in handling 20% of missing daily rainfall observations at Kuching Third Mile Station. Comparative analyses were made against the Levenberg Marquardt Feedforward Neural Network (LMFNN) and the K-Nearest Neighbour (KNN) algorithm;

both were acknowledged for their reliability in addressing missing rainfall data. The results indicate that GWOFNN outperformed KNN and LMFNN in the coefficient of correlation (r) and mean absolute error (MAE) performance criteria.

Keywords: Grey Wolf Optimiser (GWO), Levenberg Marquardt (LM), hyperparameter, missing data prediction, K-Nearest Neighbour (KNN)

1. Introduction

Rainfall data is one of the essential observed environment data for hydrological and ecosystem modeling, where the performance of most hydrological models relies on the collected data's availability and accuracy (Kim & Ryu, 2016). However, missing rainfall data is unavoidable due to errors and mistakes during the data collection. Generally, missing data can be caused by a defect in machinery and equipment, human error in managing the data, and natural disasters that may damage the equipment on site. Conventional approaches such as zero substitution, mean substitution, and data deletion are often used to treat missing data at the preprocessing stage (Gill et al., 2007; Chiu et al., 2021a). However, these approaches are not recommended, as valuable information and data distribution may not be preserved, resulting in biased prediction studies. Hot deck imputation is another approach that can be used to replace the missing precipitation data. Malaysia's current practice is to impute the missing precipitation data by substituting the missing values using the measurements from neighboring gauging equipment or rainfall stations at the same timeline (Malek et al., 2010; Chiu et al., 2021b). Nonetheless, this method is not feasible as missing data may co-occur at the neighboring observations, and it is yet scientifically proven to be accurate (Lai et al., 2023).

The data imputation model is currently one of the most popular approaches to treat missing data in various fields. The data imputation model can be derived from data mining, machine learning, and regression techniques. Empirical artificial intelligence (AI) based imputation approaches that include Artificial Neural Network (ANN) and data mining-based imputation models are favored in recent imputation studies to address the missing data of many research fields. Empirical models are also known as data-driven or parametric models that only consider the information from the existing data without accounting for the complex features and processes of the hydrological system (Dawson & Wilby, 2001; Devia et al., 2015). Reduced consideration of features and processes