

METAHEURISTIC ALGORITHMS AND NEURAL NETWORKS IN HYDROLOGY

Edited by
**Kuok King Kuok and
Md Rezaur Rahman**

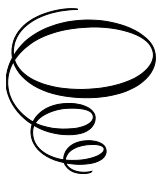
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5. Book's contents

CHAPTER 8

DEVELOPMENT OF MULTI-VERSE OPTIMIZER IN ARTIFICIAL NEURAL NETWORK FOR ENHANCING THE IMPUTATION ACCURACY OF DAILY RAINFALL OBSERVATIONS

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Abstract

This research study introduces an innovative approach to infill missing rainfall data by combining the Multi-Verse Optimizer (MVO) with a feedforward neural network (FNN) to form the Multi-Verse Optimizer Feedforward Neural Network (MVOFNN). This approach aims to overcome the limitations of conventional training algorithms for artificial neural network (ANN), which often get stuck in local optima. MVOFNN is compared against the conventional Levenberg Marquardt Feedforward Neural Network (LMFNN) and a promising data mining-based imputation approach,

the Regularised Expectation Maximization (RegEM) algorithm, for assessing its reliability and feasibility in reconstructing missing daily rainfall data. The comparison was conducted by reconstructing 20% of artificial missing daily rainfall data for Kuching Third Mile Station. Optimal hyperparameters for the ANN models were determined through trial and error combined with 5-fold cross-validation approaches. Model performance was evaluated using the correlation coefficient (r) and mean absolute error (MAE). The results revealed that all imputation models achieved high correlation predictions within the range of $0.9769 \leq r \leq 0.9797$. RegEM demonstrated the best performance among the imputation approaches, followed by MVOFNN and LMFNN. While MVOFNN did not outperform others in imputation performance, it showcased robustness, reliability, and feasibility in predicting missing daily rainfall data.

Keywords: Multi-Verse Optimizer (MVO), Levenberg Marquardt (LM), Regularised Expectation Maximization (RegEM), hyperparameters, missing rainfall data

1. Introduction

Rainfall is a critical climatic variable often used in climatological and hydrological modeling and simulation studies (Hema & Kant, 2017; Kuok et al., 2019). Accurate climatological and hydrological prediction studies often require consistent long-term and high-resolution climate variables (Sillmann et al., 2017). However, missing climatic data is often unavoidable due to limitations in data collection and failure of gauging equipment on sites. In addition, missing rainfall observations are often difficult to predict accurately due to their temporal and spatial variability. For handling the issues of missing data, hot-deck imputation, zero imputation, and listwise deletion are some of the conventional approaches adopted in various research fields (Pagano et al., 2014; Chiu et al., 2019; Chiu et al., 2021a). They are also treated as a pre-processing effort of the collected variables. However, these approaches are not reliable and scientifically supported. Introducing biases into the datasets may lead to unreliable and biased simulation results. Hot-deck imputation is practiced in Malaysia for missing rainfall data records (Malek, 2008; Chiu et al., 2021b). However, it is unreliable as it fails to function when the neighboring measurements are missing simultaneously.