METAHEURISTIC ALGORITHMS AND NEURAL NETWORKS IN HYDROLOGY

Edited by
Kuok King Kuok and
Md Rezaur Rahman

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This book first published 2024

Cambridge Scholars Publishing

Lady Stephenson Library, Newcastle upon Tyne, NE6 2PA, UK

British Library Cataloguing in Publication Data
A catalogue record for this book is available from the British Library

ISBN: 978-1-0364-0804-6
ISBN (Ebook): 978-1-0364-0805-3

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CHAPTER 5

WHALE OPTIMIZATION NEURAL NETWORK FOR DAILY WATER LEVEL FORECASTING CONSIDERING THE CHANGING CLIMATE

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Abstract

The influence of climate change is crucial to ensure effective planning and management of water resources in the future. Researchers previously adopted conventional ANN models for solving optimization problems. However, conventional artificial neural network (ANN) models exhibited a proclivity for local optima trapping, rendering them ineffectual as the complexity of optimization problems increased. The problem can be solved using metaheuristic-based ANN models named Whale Optimization Neural Networks (WONN) for developing a water level model at the Batu Kitang Submersible Weir (BKSW). Hyper-parameters setting was carried out to determine the optimal configuration of WONN using GFDL-CM3 Global Circulation Model (GCM) under the RCP4.5 scenario. A total of 2555 daily data were used, where 70% were used for training and 30% for testing. The models' performance *are evaluated with average mean absolute error (MAE_{avg}), average root mean square error ($RMSE_{avg}$), and average coefficient correlation (r_{avg}). Results revealed that the optimal configuration of WONN was found to be 18 hidden nodes (hn), 30 search agents (sa), 250 Maximum Iteration (Miter), and 2500 epochs, yielding MAE_{avg} of 0.1425, $RMSE_{avg}$ of 0.1989, and r_{avg} of 0.9097. The future long-term daily weir water level is forecasted to increase over the years, and further efforts and measurements will be required to control the water downstream for flood mitigation purpose.*

Keywords. Whale Optimization Neural Network (WONN), Batu Kitang Submersible weir, Climate Change, Water Level Forecasting

1. Introduction

One of the key elements that seriously affects both regional and global hydrological cycles is climate change (IPCC, 2013). Many academics and researchers are aware of this issue, and numerous studies have shown that climate change has affected water levels and rainfall patterns (Ercan et al., 2013; Kueh & Kuok, 2016). Ahmadalipour et al. (2019) stated that climate change can cause flooding, drought, increasing sea levels, and lengthening the dry season. Furthermore, Orkodjo et al., (2022) discovered that decreasing river streamflow due to climate change will probably reduce the amount of water available in the future. Therefore, an accurate estimation of the future water level of the weir is required to mitigate the impacts of climate change and support engineers, planners, and managers of dams and weirs in making adaptive management decisions. In order to meet the needs, this study is driven to accurately anticipate future weir water levels while taking the effects of climate change into account.

Numerous studies have been conducted recently on applying ANNs in various water-related activities (Kuok & Bessaih, 2007; Das et al., 2016; Li et al., 2016; Teng & Kuok, 2021; Lai et al., 2023). This is because ANN models can effectively handle the complex, nonlinear, and dynamic nature of hydrological processes, which are known for producing a lot of noisy data (Kuok et al., 2010; Lai et al., 2019). Furthermore, ANNs can be trained by utilizing the downscaled meteorological variables from observed local station data and climate data from global climate models (GCMs) (Kuok et al., 2019). With this developed model, ANN is able to predict the corresponding future weir water level in the study area while accounting for the effects of climate change.