Applying Machine Learning Techniques to Evaluate Water Quality in Reservoirs

Chou Jui-Sheng[1] and Hoang Ha-Son[1]

[1]National Taiwan University of Science and Technology

November 16, 2022

Abstract

Not only are reservoir managers and aquatic scientists concerned with the environmental effects of water quality, civil engineers must also consider water quality to comply with regulations in the construction of new reservoirs, or in making structural and operational modifications to existing reservoirs. This study establishes a machine learning approach for predicting Carlson's Trophic State Index (CTSI), which is a frequently used metric of water quality in reservoirs. Data collected over ten years (1995-2016) from the stations at 20 reservoirs in Taiwan were preprocessed as the input for the modeling system. Four well-known artificial intelligence (AI) techniques, ANN (Artificial Neural Network), SVM (Support Vector Machine), CART (Classification And Regression Technique), and LR (Linear Regression), were used to analyze in baseline and ensemble scenarios. Moreover, one variation of support vector machine was integrated with a metaheuristic optimization algorithm to develop a hybrid AI model. The comprehensive comparison demonstrated that the ensemble ANN model, based on tiering method, is more accurate than the other single, ensemble, and hybrid models. The novelty of this study is providing a new approach of AI models, reducing the complexity of measuring three traditional parameters of CTSI formula, as an alternative to the conventional approach to predicting CTSI. This work contributes to the improvement of water quality management by providing a versatile technique that offers diverse predictive methods to meet the specific requirements of practitioners.

Applying Machine Learning Techniques to Evaluate Water Quality in Reservoirs

Jui-Sheng Chou and Ha-Son Hoang
Department of Civil and Construction Engineering, National Taiwan University of Science and Technology, Taipei, Taiwan

Introduction

➢ Water in reservoirs is a vital resource for all living organisms . Various properties of water in **reservoirs**, especially its **quality**, must be assessed. Assessing the quality of water critically enables managers to **develop optimal water resources management plans**.
➢**Carlson's Trophic State Index** (CTSI), a fundamental index that was developed in 1977, is commonly used by water management agencies and organizations around the world.
➢The **Taiwan Environmental Protection Administration** (TEPA) has adopted **CTSI** as the official index of water quality, accounting for its state of eutrophication, in reservoirs.
➢While classical methods evaluate the Carlson's Trophic State Index from conventional variables, recent researches has sought active solutions for water management.
➢AI based approaches have advantages over the traditional deterministic methods as they reduce the complexity that is associated a large number of factors and the necessary sophistication of quantifying traditional water parameters.

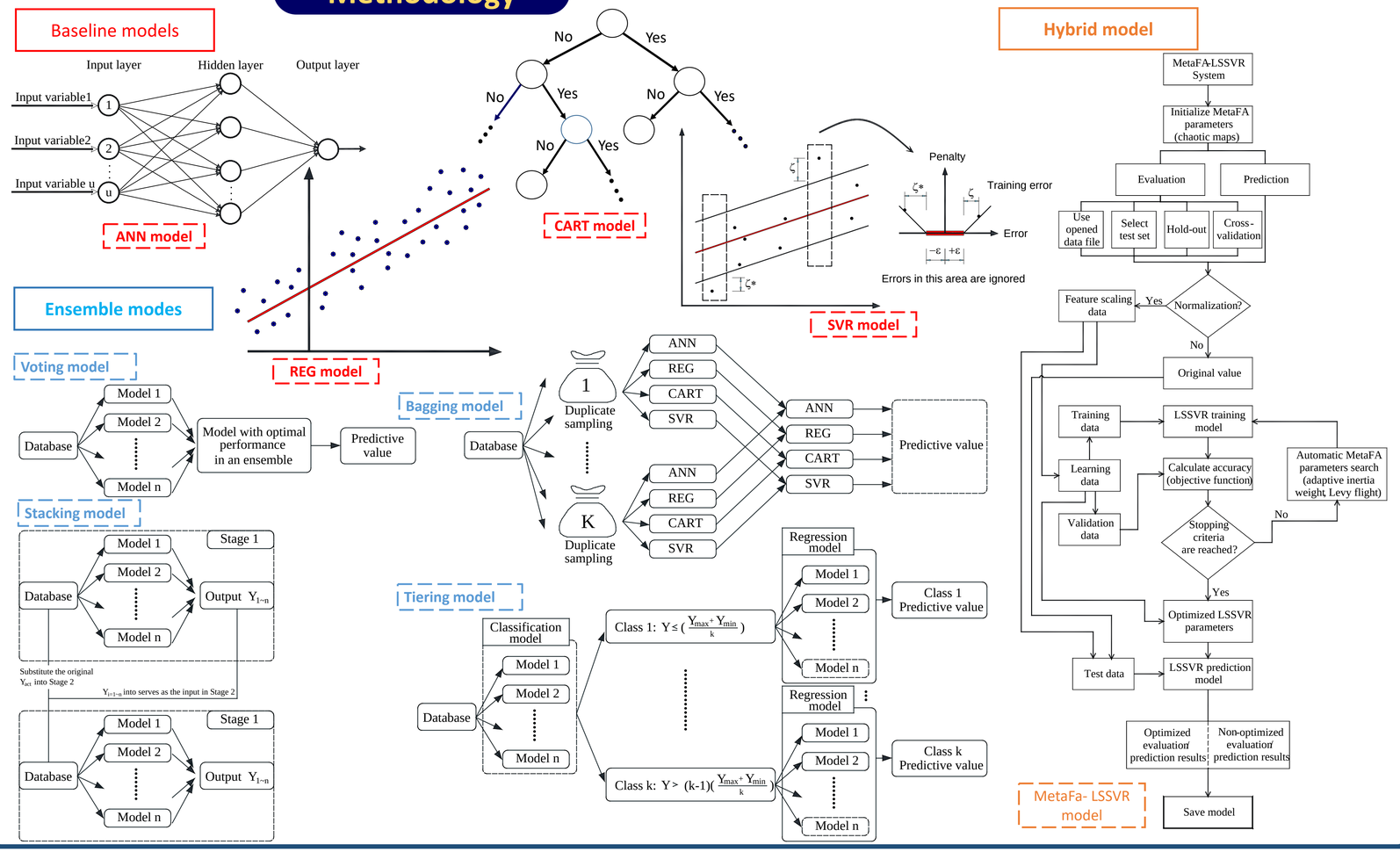
Objectives:

➢ Develop a versatile water quality modeling approach, including single, ensemble, and hybrid models.
➢ Enable managers or water scientist who use AI for water management to choose the best analytical tools for various purposes.

Data

Geographical locations of reservoirs

Methodology



Conclusions and Recommendations

Data mining applications

➢ Provide a versatile modeling system for the dataset of water quality in reservoir using multiple AI technique in several analytic tools.
➢ Offer a comprehensive comparison among several baseline models and sophisticated models.
➢ Examine the efficacy of AI application in diverse software.

Water quality management

➢ Propose an alternative to the conventional approach for assessing and predicting CTSI.
➢ Reduce the cost and complexity of the experimental measurement in determining three traditional parameters in the CTSI formula.
➢ Offer diverse predictive methods to meet the specific requirements water quality managers.
➢ Support the experts to give the optimal solutions in water quality researches, contribute to the sustainable development of environment.

Acknowledgements

• National Taiwan University of Science and Technology
國立臺灣科技大學 NATIONAL TAIWAN UNIVERSITY OF SCIENCE AND TECHNOLOGY

• Ministry of Science and Technology
科 技 部 Ministry of Science and Technology

Results