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RESEARCH ARTICLE

A decision fusion method based on classification models for water quality monitoring

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Abstract

Monitoring of water quality is one of the world's main intentions for countries. Classification techniques based on support vector machines (SVMs) and artificial neural network (ANN) has been widely used in several applications of water research. Water quality assessment with high accuracy and efficiency with innovational approaches permitted us to acquire additional knowledge and information to obtain an intelligent monitoring system. In this paper, we present the use of principal component analysis (PCA) combined with SVM and ANN with decision templates combination data fusion method. PCA was used for features selection from original database. The multi-layer perceptron network (MLP) and the one-against-all strategy for SVM method have been widely used. Decision templates are applied to increase the accuracy of the water quality classification. The specific classification approach was employed to assess the water quality of the Tilesdit dam in Algeria as a study area, defined with a dataset of eight physicochemical parameters collected in the period 2009–2018, such as temperature, pH, electrical conductivity, and turbidity. The selection of the excellent parameters of the used models can be improving the performance of classification process. In order to assess their results, an experiment step using collected dataset corresponding to the accuracy and running time of training and test phases, and robustness to noise, is carried out. Various scenarios are examined in comparative study to obtain the most results of decision step with and without feature selection of the input data. From the results, we found that the integration of SVM and ANN with PCA yields accuracy up than 98%. The combination by decision templates of two classifiers SVM and ANN with PCA yields an accuracy of 99.24% using k-fold cross-validation. The combination data fusion enhanced expressively the results of the proposed monitoring framework that had proven a considerable ability in surface water quality assessment.

Keywords Surface water quality monitoring · Principal component analysis · Feature selection · Support vector machine · Artificial neural network · Decision templates

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Highlights
- New intelligent water quality classification is performed using data combination fusion and features selection.
- ANN and SVM methods have been proposed for water quality classification status.
- The final decision is performed using decision templates rule combination based on probabilistic output from both the two classifiers.
- Real database from Tilesdit dam (Algeria) are used for evaluation.
- A superior accuracy of up to 99.24% was obtained by the proposed approach and of all used methods.

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Introduction

The quality of surface water plays a crucial and strategic role in people's health, sustainable development, and ecological systems (Wang et al. 2013). However, due to its limited availability, freshwater is subject to contamination from various sources, including home and industrial pollutants, agricultural runoff, and other sources (Soltani et al. 2021; Oukil et al. 2021). The deterioration of freshwater quality currently is one of the biggest environmental issues (Dilmi and Ladjal 2021). Surface freshwater resources, such as rivers, lakes, and reservoirs, are also important and require careful treatment because the underground water supply is generally insufficient to meet market demand (Soltani et al. 2020). Because it can be used immediately and does not require costly treatments or, more crucially, pose a danger