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Self-Organizing Maps-Based Features Selection with Deep LSTM and SVM Classification Approaches for Advanced Water Quality Monitoring

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Abstract: Water quality control and monitoring is an important concern of countries over the world. We present in this work, the use the self-organizing feature maps of Kohonen (SOFM) as features selection technique and advanced classification techniques, such as: Long Short-Term Memory (LSTM) and Support Vector Machines (SVM). This study involved the advanced assessment of surface water quality from Tilesdit dam in Algeria. Typically, water quality status is determined by comparing collected data with water quality standards. LSTM and SVM have been applied with SOFM-based features selection for water quality classification. In this work, the training step is realized using the mentioned approaches to supervise the water quality from several physicochemical parameters. Eleven of them were collected in 4 seasons during the period (2016-2018) from study area. Experiments step using a mentioned dataset in terms of accuracy (training and test), running time and robustness, is carried out. The performance of our approach is optimized by regulating the parameter values using a SFOM based features selection method. The proposed approach outperforms current conventional methods, as this approach is a combination of strong feature selection and classification techniques. Optimal input features are selected directly from the original datasets, aiming to reduce the computational time and complexity. The impact of this result is significant both technically (lower learning time) and economically (reduced the number of sensors) and can improve obviously the performance of our monitoring system. The accuracy is more than 98% in training and testing steps with features selection process for the LSTM and SVM models. The best results of sensitivity, specificity, precision, and F-score of the two proposed models were ranged all between 96,99 % and 100%. In a nutshell, the two comparative machine learning methods provide very high classification accuracy and make a considerable solution for water quality control and monitoring.

Keywords: Water quality monitoring, Self-organizing feature maps, Features selection, Deep learning, Long short-term memory, Support vector machines, Classification.

1. Introduction

Surface water quality assessment presents a crucial and fundamental role in health protection, ecological systems, social development, agriculture, and industry, and improving environmental performance, so we should keep and protect the use of water [1]. However, conventional techniques are used to assess the water quality including: Matter Element Model, Fuzzy Synthetic Evaluation, Gray Analysis Method, Logistic Curve Model, Attribute Recognition Model and Fuzzy Logic and k-Nearest Neighbors method (k-NN) [2]. These techniques require expertise in data analysis and knowledge of water quality parameters. The above limitations can be overcome using machine learning methods so that water quality monitoring based on available sensor-generated data becomes feasible and cost-effective and his techniques are becoming very useful and popular for water quality problems [3]. The conventional techniques are unsuitable and