Modeling eutrophication using the hybrid ABC–SVM–based approach, multilayer perceptron neural network and M5 model tree in the Pozón de la Dolores lake (Northern Spain)

P.J. García Nieto[a,*], E. García–Gonzalo[a], J.R. Alonso Fernández[b], C. Díaz Muñiz[b]

[a]Department of Mathematics, Faculty of Sciences, University of Oviedo, 33007 Oviedo, Spain

[b]Cantabrian Basin Authority, Spanish Ministry of Agriculture, Food and Environment, 33071 Oviedo, Spain

Abstract

Eutrophication is a water enrichment in nutrients (mainly phosphorus) that generally leads to symptomatic changes and deterioration of water quality and all its uses in general, when the production of algae and other aquatic vegetations are increased. In this sense, eutrophication has caused a variety of impacts, such as high levels of Chlorophyll a (Chl-a). Consequently, anticipate its presence is a matter of importance to prevent future risks. The aim of this study was to obtain a predictive model able to perform an early detection of the eutrophication in water bodies such as lakes. This study presents a novel hybrid algorithm, based on support vector machines (SVM) approach in combination with the particle swarm optimization (ABC) technique, for predicting the eutrophication from biological and physical-chemical input parameters determined experimentally through sampling and subsequent analysis in a certificate laboratory. This optimization technique involves hyperparameter setting in the SVM training procedure, which significantly influences the regression accuracy. Additionally, a multilayer perceptron network (MLP) and M5 model tree were fitted to the experimental data with comparison purposes. The results of the present study are two-

*Corresponding author. Tel.: +34-985103417; fax: +34-985103354.
E-mail address: lato@orion.ciencias.uniovi.es (P.J. García Nieto).

fold. In the first place, the significance of each biological and physical-chemical variables on the eutrophication is presented through the model. Secondly, a model for forecasting eutrophication is obtained with success. Indeed, regression with optimal hyperparameters was performed and coefficients of determination equal to 0.90 for the Total phosphorus estimation and 0.92 for the Chlorophyll concentration were obtained when this hybrid ABC–SVM–based model was applied to the experimental dataset, respectively. Furthermore, the results obtained with the MLP approach and M5 model tree are clearly worse than those obtained with the ABC–RBF–SVM–based model. The agreement between experimental data and the model confirmed the good performance of the latter. Finally, conclusions of this innovative research work are exposed.

Keywords: Support vector machines (SVMs); Artificial bee colony (ABC); Artificial neural networks (ANNs); M5 model tree; Eutrophication in water bodies; Regression analysis

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