Seawater-type Based Neural Networks for Ocean Color Data Inversion

Ari Saptawijaya[1,3], Davide D'Alimonte[1] and Tamito Kajiyama[2]

[1]*Centro de Inteligência Artificial (CENTRIA), Departamento de Informática, Faculdade de Ciências e Tecnologia, Universidade Nova de Lisboa, Portugal,* davide.dalimonte@gmail.com

[2]*Centro de Informática e Tecnologias da Informacão (CITI), Departamento de Informática, Faculdade de Ciências e Tecnologia, Universidade Nova de Lisboa, Portugal,* t.kajiyama@fct.unl.pt

[3]*Fakultas Ilmu Komputer, Universitas Indonesia, Indonesia,* saptawijaya@cs.ui.ac.id

Abstract: Ocean Color (OC) inversion schemes use space-born radiometric observations to derive concentrations and/or optical properties of seawater constituents. Inversions schemes supporting environmental and climate studies for regional applications have been implemented in the recent years to improve data product quality for specific seawater-types (WTs). Still, regional algorithms complementing operational space missions results demand further advances to meet the required accuracy of derived products for an effective use of remote sensing data. A challenge is the capability to select the most appropriate inversion model on the basis of satellite atmospherically corrected radiometric values. This aspect is here investigated by using Multi Layer Perceptron (MLP) neural networks for data analysis and classification. Synthetic data have been generated for this scope with a forward OC model. These samples have then been used to train and assess the MLP performance considering different WTs with optical properties driven by: chlorophyll (Chl-a), colored dissolved organic matter (CDOM), non-pigmented particulate matter (NPPM), as well as a mixture of Chl-a, CDOM and NPPM (henceforth MIXI). An additional data set has been produced for testing purposes by merging records representing the four different WTs. Each data set includes pairs of spectral remote sensing reflectance at six different wavelengths (i.e., MLP inputs), and corresponding optically active seawater constituents (i.e., Chl-a concentration, NPPM concentration and CDOM absorption). Simulated data have been generated accounting for uncertainty budgets of real measurements. Each data set includes a different number of samples, as expected with genuine field measurements. The retrieval of optically active seawater compounds has been tested considering two different data regression MLPs: the first with a single output unit (i.e., either Chl-a, or CDOM or NPPM), and second with three output units (i.e., Chl-a, CDOM and NPPM at the same time). Results indicate that a single output allows for a better MLP performance, which can be explained considering that increasing the number of output units makes the MLP training more difficult. Another outcome is the importance of selecting a proper MLP architecture as a function of the specific task. For instance, a larger number of hidden neurons has been found relevant in the case of the MIXI data set, which represents a more complex optical case. A success rate of 90% in WT classification has been achieved, accounting for the different fractions of training samples pertaining to each WT by applying a balancing mechanism based on record duplication. A class-weighting mechanism is now under development to devise a new MLP learning function that addresses the issue of unbalanced training data analytically. Acknowledging that MLP classification results represent WT posterior probabilities, an integrated machine learning approach has been finally set up by joining MLPs for data regression and classification in a composite scheme. Results indicate that this approach is valuable to support the use of regional ocean color inversion schemes by decomposing the overall challenge in sub-components, optimally addressing each of them, and combining the individual solutions in a principled framework.

Keywords: neural network, regional algorithms, ocean color, remote sensing.