Machine Learning Algorithms for Satellite Remote Sensing of Ocean Color in Coastal Waters

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Satellite remote sensing of ocean color provides a synoptic view of global oceans, and has greatly improved our understanding of marine ecosystem productivity and the ocean's role in Earth's climate system. Central to the ocean color remote sensing is the development of algorithms that can accurately infer optical properties of sea water from satellite reflectance measurements. However, algorithms developed for the open ocean perform poorly in optically complex estuaries and coastal oceans, regions that support productive fisheries but are most affected by human activities. In this study, machine learning algorithms are used to uncover complex nonlinear relationship between chlorophyll concentration and satellite reflectance in coastal waters. Three machine learning models are used to identify the relationship: support vector regression (SVR), relevance vector machine (RVM) and artificial neural networks (ANN). Their performances are then compared against NASA's operational algorithm OCM3 developed for the open ocean and a generalized linear model. For the log-transformed test data, the root-mean-square error (rmse) is 0.19, 0.17 and 0.3 for SVR, RVM and ANN, respectively; the corresponding correlation coefficient (rsq) is 0.57, 0.66 and 0.21; and the mean error (bias) is -0.00004, -0.11 and 0.03. SVR and RVM perform much better than OCM3 which has rmse of 1.07, rsq of -0.002, and bias of -0.82, and also capture the seasonal evolution of chlorophyll distribution in the Chesapeake Bay. These algorithms advance satellite remote sensing of ocean color in coastal waters, and may help develop better management strategies of coastal resources by providing a cost-effective tool to monitor water quality and marine productivity.

Awards Won:

American Statistical Association: Second Award of $1,000

Fourth Award of $500